DOCUMENT RESUME

ED 272 096 HE 019 539

AUTHOR Galbraith, Peter L.; Carss, Brian W.
TITLE Resource Allocation Procedure at Queensland University: A Dynamic Modelling Project.
INSTITUTION Queensland Univ., Brisbane (Australia). Dept. of Education.
PUB DATE Mar 86
NOTE 175p.; Appendix C, "Model Equations," will not reproduce well.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC07 Plus Postage.
DESCRIPTORS *Administrative Change; Budgeting; *College Administration; Decision Making; *Departments; *Financial Policy; Foreign Countries; Higher Education; Models; Money Management; *Organizational Change; Policy Formation; *Resource Allocation; School Organization
IDENTIFIERS *Univeristy of Queensland (Australia)

ABSTRACT

A structural reorganization of the University of Queensland, Australia, was undertaken to promote efficient resource management, and a resource allocation model was developed to aid in policy evaluation and planning. The operation of the restructured system was based on creating five resource groups to manage the distribution of academic resources to departments. Positive outcomes of restructuring included: time scale of decision-making, additional flexibility with funds, better information, focus for decision-making, unifying influence, and cohering new directions. Negative outcomes included: increased administrative load, confrontation between department heads, between-group competition, increasing bureaucratization, and impacts on faculties and deans. Concerns about the change that were identified included: the rationale for tenurable positions and chairs, ad-hoc decision-making, staff personal problems, and inequality of access to information. The dynamic model represented the resource allocation and management mechanisms introduced in the structural reorganization. The dynamic model was evaluated by subjecting it to a variety of scenarios in the form of system stresses and policy alternatives. Questionnaires and interview schedules are appended, along with equations for the model. (SW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

DEPARTMENT OF EDUCATION

RESOURCE ALLOCATION PROCEDURE AT QUEENSLAND UNIVERSITY: A DYNAMIC MODELLING PROJECT

Peter L. Galbraith and Brian W. Carss
March, 1986

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Peter L. Galbraith
Univ of Queensland

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

UNIVERSITY OF QUEENSLAND

Background

With economic stringency a fact of life institutions of higher education have found their budgets frozen or cut at a time when the overall demand for their courses has never been higher. However the demand is uneven so that extreme pressures on some courses can be contrasted with slackening demand elsewhere. The situation has placed severe strain on resource allocation decision making whereby the meeting of new needs implies cuts at the expense of other sections of the university community. In an attempt to increase the efficiency of resource management the University of Queensland (Australia) has restructured its organization to create five resource groups to manage the distribution of academic resources to departments. The respective groups are administered by pro-vice-chancellors and are composed of departments in cognate areas. The departments compete for funds from their group subject to tensions of fluctuating demand. The groups in turn compete for central funds managed at a higher level through an Academic Resources Planning Committee (ARPC). These central funds are ultimately dependent upon the funding policy of the federal government. The faculties whose concern is with the administration of courses and students contain departments that may be located in different resource groups.

The present study was funded by a Special Project Grant. Its purpose was to review the operation of the restructured system and to construct a dynamic model that would be an aid in policy evaluation and planning. This report describes this modelling exercise together with implications for institutional planning. The first part of the report contains qualitative data that illustrates the emerging problems that such a restructuring generates as well as providing background for the construction of the quantitative model.

CONTENTS

Executive Summary 4
    Vice Chancellioriate 4
    Faculties, Deans and Heads of Departments 6
    The Dynamic Model 9

Part 1. A Qualitative Review 13
    Introduction 13
    Vice chancellioriate 16
    Relationship between Heads and the PVC 19
    Group Resource Allocation Mechanisms 20

Positive Outcomes of Restructuring 23
    Time scale of decision-making 23
    Additional flexibility with funds 23
    Better Information 24
    Focus for decision-making 24
    Unifying Influence 24
    Cohering new directions 25
Negative Outcomes of Restructuring 25
    Increased Administrative load 25
    Confrontation between Heads of Departments 26
    Between Group Competition 26
    Increasing Bureaucratization 27
    Impact on Faculties and Deans 27
Areas of Concern 28
    Rationale for tenurable positions and Chairs 28
    Ad-hoc decision making 29
    Personal Problems of Staff 29
    Inequality of Access to Information 29
    Costly Items Joint Facilities and General Staff 30
    Solidification of Groups 31
    Timescale for restructuring 31
    Cross Group Initiatives 32
    Role and Functioning of Committees 33
Deans and Faculties 35
    Perceptions of Deans 37
    Effect of Restructuring upon Faculties 37
    Relationships with Heads 37
    Contribution to Group Decision Making 38
    Achievements of the Group Structure 39
    Concerns Generated by the Group Structure 39

Part 2. The Resource Allocation Model

    The Resource Allocation Model 44
    Model Structure 46
    Causal Diagram 49
    Feedback Structure 53
    Adjustment Allocations 60
    Adjustment Loops 60
    Simulation Experiments 63

Basic Experiments 1-6 65
Reading the Output 65

Dynamic Model Summary

Parameter Sensitivity 109
Policy Analysis 110
Adjustment Allocations 112

Appendix A 114
Appendix B 122
Appendix C 131

THE UNIVERSITY'S STRUCTURAL REORGANIZATION

PETER L. GALBRAITH & BRIAN W. CARSS

EXECUTIVE SUMMARY

The statements presented here, are summary statements, which should be read from the standpoint of the people nominated in the heading. In other words they reflect the investigators assessment of the specific views of that group together with commentary.

Vice Chancelloriate

The Vice-chancelloriate views the committee of P.V.Cs as a task-oriented, problem-solving group with respect to resources, staffing, SSP, part-time monies etc. On staffing matters the P.V.Cs. have to consult with the Vice-Chancellor on the merit of filling a tenured position.

ARPC is viewed as a committee with broader representation which is particularly concerned with policy issues. It takes on-board recommendations from the P.V.Cs committee, but as the P.V.Cs hold the voting majority in the ARPC, they, the P.V.Cs, can invoke their will. However, this strengthens the role of ARPC in that if the PVCs are at odds on an issue, the issue can be referred to the wider audience of ARPC to consider.

Members of ARPC take for granted the existence of the major support groups within the University i.e. The Prentice Computer Centre, the Library and the University Administrative Services. Because these support services are taken for granted, they are afforded a degree of protection from the intrusion of the academic resource groups who may seek to increase their own resource allocation at the expense of the support groups.

We suggest that the continued existence and support of these service units is not a matter for negotiation in principle. However, the level of their financial support should always be a matter for scrutiny and justification.

The PVCs are acting as effective filters for many problems that previously ended up on the VC's or Dep.VC's desks, with the result that Heads of Departments get answers to problems affecting their staff more quickly and thereby reducing the level of staff frustration.

It was envisaged that the budgeting process would be 'bottom-up' under the new organizational structure. However, in practice, the Vice-Chancelloriate view budgeting very much as a 'top-down' exercise. Both processes appear to be operating with the PVCs becoming the pivotal elements in the budgetary process. On balance, it is still a 'top-down' dominated process.

The physical location of the PVCs in their respective groups has encouraged communication and brought about greater understanding on the part of the PVC of a department's operation. On the other hand, staff are aware of the presence of the PVC who can be seen to be concerned about their problems, and this is a good thing.

Within the group of PVCs, there is a general acceptance of a competitive environment with respect to resources, but a more cooperative environment pervades when managerial, staff and student matters are being considered. There is no doubt that it has been impossible for the PVCs to separate themselves from academic matters. Initially they were not viewed as having any academic leadership role in the beginning, but it is obvious now, that resource matters cannot be separated from academic matters.

For effective planning to take place, there is an obvious need to commit resources to the planning process. This is particularly true for strategic planning where detailed data needs to be collected, analysed and interpreted within the constraints of a number of strategy alternatives. We believe, this could be accomplished through the establishment of a strategic planning research group.

Faculties, Deans and Heads of Departments

The present role of the Faculties is seen to be ambiguous in that by their charter they have academic responsibilities, but these are tempered by resource implications for new projected academic developments. This conflict of interests is made to seem bigger because in the past, academic matters were separated from resource allocation considerations. It is vital that academic decisions and their associated resource implications be brought together at an early stage in their development.

The separation of resource matters and academic developments would seem to be the main contributing factor to the substantial increase in committee and administrative work by Deans since the reorganization took effect. These increased administrative demands have affected the morale of some Deans and Heads of Departments and detracted from their primary responsibilities of leadership, teaching and research.

It would seem that the degree of frustration of Heads and Deans is inversely related to the proportion of their resources coming from the University. People see themselves as having given time and energy to supporting structures which have contributed relatively little to their total budget. These comments apply particularly to departments who receive substantial amounts of money from external sources, thereby giving them the luxury of being relatively independent of university funds.

Deans, within their Resource groups, viewed themselves as playing an enhanced role by being able to take a more dispassionate view of the Group's budget proposals and proposed academic developments.

The Deans' and Heads' of Departments perception of the Vice-Chancelloriate is clouded by a lack of information as to the composition and power of such committees as ARPC. ARPC is viewed by some, as "mafia-like" and as being distant, mysterious, all powerful and secretive.

Concern was expressed about the apparent reduced role of the Academic Board and its Standing Committee. This is in direct contrast to Senate, which appeared to some, to be exercising a power of veto over decisions taken elsewhere in the University.

The competition between Resource Groups and the cooperative/competitive balance between departments within the Groups are delicate issues which need careful handling and nurturing.

Heads of Departments continue to be frustrated by having to seek information and make submissions for relatively trivial items, such as pieces of furniture. This, and other matters contrasted starkly with the effectiveness of the procedures channelled through the PVCs. Heads also commented on the contrast that exists between how the PVCs manage academic staff and how general staff are handled elsewhere. This contrast was not flattering to the management of general staff. We believe that this is another example of the need to consolidate all resource matters into a single decision making structure based on the Resource Groups.

The Dynamic Model

Within the competitive environment of the Groups and their departments, the principal challenge remains to devise planning procedures that will enable resources to be moved across departmental boundaries and between Groups in a non-disruptive way as needs and demands change. The dynamic model was constructed to capture the essential features of the actual university's organizational system. If the assumptions and the mechanisms of the model are accepted then, its output suggests the following:

(1) It is unwise to attempt to fully adjust for sudden changes in enrolment levels in the year that they occur as this generates instability in the system, particularly when the system is volatile with respect to changes in demand for places. A triennium can be regarded as a suitable time period over which to accommodate major changes.

(2) While an application of stringent resource/student ratios can be used to restrict entry to subjects that are being subjected to enrolment pressures, the model behaviour indicates that this has minimal impact on the timescale of the adjustment for equilibrium. Timescales are controlled by allocation policies and not by entry policies, which affect amplitudes but not periods.

If allocation policies based on smoothed enrolment rates are used, then the adjustment time is controlled by the enrolment averaging time and not by the size of the enrolment. While a stringent policy may reduce the initial "pain" of an enrolment blowout, it will lead ultimately to fewer resources for the Group or department under a distribution policy based on average enrolments. It is recommended that as far as possible, elasticity be retained in the application of resource/student ratios.

(3) Model behaviour is insensitive to changes in the COST/WSU ratio. This means that while changes in this ratio will lead to the expected alterations to the total Group costs, there is no prolonged disruptive effect in bringing about this change. This means in turn, that the allocation profiles based on enrolments are robust to changes in COST/WSU ratios and hence the search for effective methods of resource distribution need not be complicated by hypothetical concerns about possible destabilizing effects of cost changes.

(4) Resource allocation principles should be completely severed from historical precedent. Rather, they should be based upon "dynamic history" whereby allocations are made in terms of constantly updated, and smoothed enrolments. Stability considerations suggest a time of three (3) years as being satisfactory.

(5) In order to maintain the flexibility to adjust resources in line with changes in smoothed enrolment rates it is necessary to have a pool of resources free from long term commitment. Staffing policies which ensure this flexibility is maintained are

necessary. For example, an adequate proportion of fixed term appointments will provide a continuing base of liquid assets across Groups and departments.

(6) Resource allocation planning should not be in terms of some external enrolment goal. External goal-directed allocation procedures effectively remove the influence of feedback and lead to persistent advantage or disadvantage within parts of the system. By contrast, the "dynamic history" policy uses feedback to equalize advantages or disadvantages throughout the organization.

These comments apply particularly to the volatile sections of the university where actual demand can vary widely and unpredictably from the expected demand. For high-demand courses, such as Medicine, it is known that enrolment goals are always met exactly so that dynamic history and planned enrolment policies have identical outcomes.

(7) Attention should be given to withholding a small amount of the total Group money from the initial basic resource allocation. Following an examination of Group conditions, adjustment allocations could be made to mitigate conditions of extreme need, should they be warranted.

(8) In allocating additional resources or in distributing "pain" by imposing cuts across Groups in the event that resources available do not match demands, we wish to draw particular attention to the

problems associated with adopting a proportional allocation procedure. It is our belief that the application of proportional allocation involves the trading-off of "fairness"against "effectiveness". If the intention is to help a disadvantaged Group(s) then adopting a proportional allocation policy is neither as fair or as effective as one might hope. It is recommended that attention be given to devising 'criticality criteria' through which Groups can receive or lose resources according to their relative needs, and for which there is no expectation that all Groups will be treated on the same basis.

PART 1: A QUALITATIVE REVIEW

INTRODUCTION

The specific aims of this project were (a) to construct a dynamic model which represented the resource allocation and management mechanisms introduced in the structural re-organization and (b) to evaluate the dynamic model by subjecting it to a variety of scenarios in the form of system stresses and policy alternatives.

To assist in the construction of the dynamic model a number of interviews were carried out in order to attempt to identify important structural elements and their interrelationships. These qualitative data also served to cross check on the behaviour of the dynamic model. A series of interviews were carried out with the Vice-Chancelloriate, and some Deans and Heads. An invitation was extended to Heads who were not interviewed, to submit written comments. These comments were also relevant to the verifying of the dynamic model with respect to its scope and structure. The scenario which emerged was that of a competitive one, in which parts of the University compete with each other for scarce resources. The policy strategies tested in the model were aimed at seeking those, which would provide for efficiency and fairness subject to the constraints of the situation. A further purpose served by the interviews was to provide information on the actual operating procedures of the new structure as seen by a sample of its key actors. The associated findings form the qualitative part of the review which follows.

Data Collection

In a many faceted institution like a university, conditions and needs are subject to wide variation across the organisation. It makes no sense to send out a standard questionnaire and expect to obtain meaningful interpretations from aggregating responses to items. One reason is that the relevance of a given item can vary from high to low depending on the role and function of the respondent in the institution. The comments of actors in the system nearly always require a context to provide meaning, and consequently, we used the extended interview as the major method of data collection. The interviews were loosely structured so as to provide a framework relevant to aspects of the new University organization. Information was gathered on common issues from a variety of sources. In addition, those people who were interviewed were invited to add comments of their own on matters that they considered to be important, but which had not arisen during the structured part of the discussion.

Extended interviews were conducted with the following people.

Vice-Chancellor
Deputy Vice-Chancellor (Academic)
Deputy Vice-Chancellor (Fabric and Finance)
Pro-Vice-Chancellors (5)
Heads of Departments (10 - Two from each group.)
Deans of Faculties (4)

Additionally other Heads of Department were invited to submit written comments on aspects of the re-structuring. Nineteen (19) availed themselves of this opportunity. Copies of the interview schedules are provided in Appendix A. Access was also given to minutes of the following committees

Academic Board
Research Committee
Social Sciences Group Council
Senate
Academic Resources and Planning Committee

The interviews and other data gathering took place in the period from July to December 1984. Interviews were tape recorded and confidentiality was guaranteed as to all of those who participated.

For interpretation purposes, the comments were placed in a framework that enabled them to be focused on different aspects of the structure and functioning of the restructured University. In this way, it was possible to compare comments on common issues as seen through alternative eyes. The manner of reporting the data is important to appreciate. Again it makes no sense to simply add up positive and negative comments on an issue, in order to decide whether a particular matter was satisfactory or not. For example if 6 Heads of Departments were happy with a particular procedure, and 4 were most unhappy it would seem dubious to infer that the procedure was basically satisfactory. One would expect the University to be concerned that 40% of its key leaders were dissatisfied.

Similarly, frequency of comment on an issue, is not always a valid measure of its potential importance. Particularly when a new structure is developing, it can be that one Head of Department, say, becomes aware of a problem that has not yet appeared in the rest of the sample. Hence, we thought important to include items in the reported data on the basis of their perceived significance rather than on frequency alone. Where widespread comment has occurred on a particular topic, an indication is provided in the text. Bearing in mind earlier comments about the contextual importance of remarks, a significant proportion of the descriptive record of data is comprised of extended quotations from taped transcripts and written comments.

Vice Chancelloriate

This heading covers the Vice-Chancellor, two deputy Vice-Chancellors and the five PVCs. There was unanimous agreement that ARPC had replaced the former Planning Committee and that its role was moving towards that of establishing policy. In its behaviour it acted in a more or less cooperative manner.

In contrast to the committee of PVCs, which operates in a competitive environment, are issues which are now being brought to the PVCs. They are mainly personal matters of staff, which may be considered by this group in an attempt to tap into their combined wisdom.

There is a 100% overlap between ARPC and the Committee of PVCs which means that the PVCs can dominate the voting on ARPC as they hold a combined majority of votes. This suggests that there must be a distinctive role for ARPC, so that it does not become a rubber stamp for the PVCs committee.

The restructuring process has not reduced the workload of the VC or the Deputy VCs. In fact if anything, the workload has increased and the problems being presented to this small group are more difficult and more demanding of time. However, the PVCs are acting as effective filters for some problems and the speed at which they are able to respond to departmental or an individual's problems is laudatory. We did not receive any unfavourable comment on the relationships between the PVC and the departments.

The budgeting process is "top down" and the procedures cumbersome. This is evident in the amount of time taken to get a finalised budget.

ARPC and the PVCs committee both seem to be hampered in their work by not having ready access to timely data that is in an appropriate form to assist decision-making. Data collection, to answer a question, appears to be a "one-off" exercise rather than there being a continuous collection and tracking of the institution's performance criteria.

There is a need for the establishment of a strategic planning research group to carry out the detailed work of examining the implications of competing proposed developments, as well as supporting the policy considerations of ARPC. This task at present, seems to fall on the shoulders of the Vice-Chancellor and he is not able to carry through this responsibility very well because of other pressures on his time.

Operation of the Group Council Structure

As is to be expected, the operation of Group Councils is perceived as varying between groups from strongly hierarchical to very democratic. Similarly, the frequency of Council meetings varies from frequent to infrequent. In no instance did a Head of Department feel that it would have been a problem to get an issue on the agenda for a Group Council's meeting, so that while PVC's generally determined the order of business, (and indeed the agendas), this was done with a knowledge of departmental requests.

Typical comments describing perceptions of Group Council functioning were

> "More or less hierarchical - we have an occasional meeting where the PVC determines the order of business and tells us what he's thinking (or not). I can discuss matters with the PVC on an individual level - he's pretty open".

> "Our council has functioned well as a collegiate committee - even contentious issues such as academic staffing have been threshed out in an atmosphere of general cordiality, even with cut and thrust present".

As was the case with the Pro-Vice-Chancellors, there was acute awareness among Heads of Department of competition within and between groups.

> "I tnink it's (competition) inevitable given the structure and I don't particularly object to it. At a time when the University is badly underfunded, and given there are five groups, they must compete and I would have thought the major role of the PVC is at that higher collegiate level to compete for his group".

On the question of the frequency of council meetings, two groups appeared to meet less frequently than others. This elicited both positive and negative comment i.e. infrequency of meeting was regarded as an advantage in some quarters and a disadvantage in others.

One respondent described the whole re-organization as a non-event indicating that in his view it had made little or no impact on the pursuit of excellence and scholarship.

Relationship between Heads and Pro-Vice-Chancellor

Without exception the PVC's were regarded very highly. Even those Heads of Departments who had severe criticisms of aspects of the restructuring were at pains to point out that access and personal relations with the PVC were excellent, and in a number of cases exceeded their expectations. Some heads did suggest that such successes that had occurred may be because of the person, rather than the position. They were not convinced that the structure of middle management in itself ensured the benefits they observed. There was no indication of a Department's autonomy had been infringed by the restructuring and the impact on individual members of staff was said to be minimal.

Group Resource Allocation Mechanisms

The resource allocation procedures varied markedly between groups. Some of the procedures used were as follows

1. Individual submissions made by departments with the group budget then worked out and tabled by the PVC after appropriate consultation with heads.

   As one head described it

   "The council has never impinged on my consciousness at all. The mechanism seems just to be between me and the PVC".

2. The continuation of (the main elements of) an earlier system in which allocations were based on an agreed formula. The departments work with the PVC in a collegial way with co-operation (rather than confrontation) assisted by a budget sub-committee.

3. Provision of a "one-line" budget for each department based on criteria for cost/WSU worked out by the PVC after seeing each Head of Department, and in the first instance based on historical precedent. Little negotiation was permitted in the first year -

the group effectively endorsed the PVC decision. One Head of Department in noting that little public debate of criteria had occurred observed that this was probably because of likely acrimony.

"When we did talk about resources, we weren't talking seriously, but nevertheless there was a certain amount of acrimony".

4. The allocation mechanism is a mix of confrontation between heads and a clearinghouse role on the part of the PVC. After consultation with each head, the PVC brings a consolidated budget to Group Council for debate and a final approval.

"We subject them to scrutiny but our group has little manouverability"

One Head specifically indicated his opposition to any "fait accompli" situation where each was told how much he was getting.

5. The allocation mechanism is one of confrontation whereby submissions are circulated by the PVC and respective heads argue for their proposal at Group Council. In the words of one Head

"The most important attribute to obtain money is an agile tongue and to be able to marshall all your arguments."

Another opinion suggested that long-serving, experienced Heads were probably advantaged in knowing where to get documentation and how to mount a convincing case.

It was also suggested that tradition tended to dominate the eventual distribution achieved by a group vote.

"There is difficulty in getting new formulae adopted".

An overview of the comments and responses located some areas of concern arising from the procedures adopted

(a) In two of the groups it was observed that group structure comprised a set of closely aligned, historically allied departments on the one hand, and a set of individual departments on the other. It was suggested that the like departments grouped together to support one another at Group Council to their mutual advantage. It was stated that "this sort of division is much more divisive and more likely to affect things than the actions of a PVC."

(b) Several references were made to the practice of overbidding. "To get $10,000 you bid $60,000. Honest estimates won't work because they are cut proportionally when the group budget is exceeded."

The question seems to be not so much of a PVC being unaware of such strategies but whether in prescribing cuts justice is done to the "honest tenderers".

(c) In groups where there is public debate on submissions, concern was expressed that the prize goes to the best debater rather than to the greatest need.

"Those with the most persuasive arguments, and the agile debaters obtain favours - not necessarily those in greatest need."

(d) A feeling that the good relations at resource allocation meetings may be because it is known there is almost no money to bid for beyond essentials. Some concern that relations could deteriorate if more resource spoils became available.

POSITIVE OUTCOMES OF RESTRUCTURING

1. Time scale of decision making

The reduced time to obtain decisions on matters, now under PVC's jurisdiction has featured strongly in comments. Heads have appreciated that decisions that sometimes took "months and weeks" now take "days and minutes". This has been particularly appreciated in cases of staffing crises.

2. Additional flexibility with funds

(a) The facility of shifting funds from one purpose to another has been valued at departmental level.

"Wherever there are funds for non-tenured academic staff it seems you can shift them to other uses."

(b) The facility to carry money over from one year to the next by effectively using the PVC as a banker was noted appreciatively in one department.

(c) The more efficient use of group resources whereby group savings can be used e.g to start a new initiative.

3. Better Information

It has been observed that people are now better informed as to the problem faced by the University with respect to resources. One Head of Department appreciated that he could now "speak with confidence to a Departmental meeting about the real constraints of the world we are operating in." It was mentioned several times that the PVC was aware of the problems of departments in his group in a way that more remote bodies could not be.

4. Focus for Decision Making

Several Heads appreciated the identification of a single individual with a variety of requirements.

> "The big practical difference is to have the PVC instead of several bodies to take an issue to".
>
> "It's very much better - the major advantage is that instead of applying and negotiating all over the place there's a collective pocket - the group budget".

5. Unifying Influence

Several comments indicated that interaction of heads through group council had led to a better understanding of each other's work.

> "In spite of competition, the new structure has brought the Heads of Departments together. Personal relationships have been enhanced and there is now a better appreciation of other's roles".

Interaction between the departments had also been enhanced according to these comments.

6. Cohering New Directions

An example was cited of the change in nature of a group e.g. to a technology using group. It was felt that a PVC could bring together the needs of such a group more effectively than could be achieved by each department trying to make its own case.

NEGATIVE OUTCOMES OF RESTRUCTURING

This category is reserved for factors that have been deemed undesirable outcomes of the new structure in operation. It does not include reference to what might be termed deficiencies - important areas that do not seem to have been adequately provided for in the eyes of Heads of Departments. These issues are taken up in a later section.

1. Increase in Administrative Load

A number of responses referred to an enormous increase in administration and committee work. This was seen as just more competition for time although it was noted in some quarters that the preparation of a departmental budget had been a constructive exercise.

> "In this restructuring there was just a relative enlargement of the administrative side of the University at the expense of the front line part - teaching and research."

2. Confrontation between Heads of Department

This can be thought of as an opposite view to Part No. 5 of the previous section as a consequence of the competitive nature of Group Councils. It has been expressed by Heads who see the competition as promoting political, rather than academic decision making. This concern is typified by the following comment

> "I would argue with some of the parameters, and I've tried to, and its no use. The reason it's no use is because the other Departments can see that if they accept my arguments then they can take less out of my Department, and the less they take out, the less there is for them".
>
> "That's what I think might be wrong with the group structure. You really do set Heads of Departments at each other throats. My feeling is that if Departments worked together and told the PVC what to think then its our go. But they don't, so he tells them what to think."

Earlier comments upon the primacy of debating skills over actual needs in obtaining resources would contribute to this view.

3. Between Group Competition

While Heads were principally concerned with their own Group Council structures many raised issues in the wider context of the university. One such issue was the future implications of competition at the group level.

> "I felt the reorganisation would (undesirably) tend to create five mini-Universities which I think has happended to some extent."
>
> "It may allow the development of power play and undesirable tradeoffs among PVC's".

4. Increasing Bureaucratization

There were many references to the increase in middle management and reasons for it. However it was felt by some that those in more central bodies were expanding in such a way that it was doubtful whether the devolution of authority to PVC's was producing the economies of time expected. Two examples are cited.

(1) Concept of Accountability "Nobody really spelled out what it's for - it's just a means of setting up machinery to give more bureaucrats more jobs".

(2) Role of Professors document "Surely after 3 or 4 centuries of this type of University, it isn't necessary to spend time writing down the role of professors."

5. Impact on Faculties and Deans

This large and sensitive issue is considered separately in its own right. For present purposes it suffices to note that concern (in varying degrees) about the role of Faculties figured in many discussions and responses, e.g.

> "One undesirable effect of the new system has been that many staff members see the Dean as playing a diminished role in decision-making procedures."
>
> "The Faculties at the present time are not working."

> "The chief disadvantage of Faculty structure within the restructuring is in creating more administrative work which interferes with the main purpose of the advancement of learning."

AREAS OF CONCERN

This category encompasses issues raised by Heads of Department most frequently through their own initiative in discussion or througn a written communication. Some of them reflect perceived grey areas in the restructured decision making procedures. Others express reservations about the implications of the re-organization in certain areas.

1. Rationale for tenurable positions and Chairs

Reference was made to mysterious decision making as to whether replacement members of staff would be appointed to tenurable positions or not. With respect to the re-advertisement of chairs "several memos circulated by senior administrators were in conflict leading to unpleasantness." The problem was perceived as due to lack of proper consultation with Groups. Given the speed with which some key decisions can now be made there was additional concern expressed about the time taken to finalise senior appointments. This was seen as not only disadvantageous to Departments but also as likely to lose good appointments. These issues were raised in at least four different interviews and clear guidelines were sought as to whose jurisdiction the matter of new chairs came under.

2. Ad-hoc decision making

Concern was expressed in one interview that "we're getting a number of ad-hoc decisions on policy that I think, if they continue, are going to upset people." This was not seen as related to the group system but rather due to the "absence of power of the old Standing Committee which would previously have been consulted and referred such decisions to the Academic Board or elsewhere." The example of re-advertising chairs was cited as was the decision to set up the CAL unit. Several interviewees commented unfavourably on the perceived diminished role of the Academic Board and Standing Committee. The general lack of access to some important decision making was echoed in other interviews.

3. Personal Problems of Staff

Pastoral care is not a Dean's problem nor a resource matter and there is no clear avenue of assistance for Heads of Departments with major personal problems among their staff. The deputy Vice-Chancellor (Academic) would be a resource for extreme emergencies but the system was not seen to provide help for regular serious problems of this kind.

4. Inequality of Access to Information

It was clear from interview comments that knowledge of university structures and operations differed considerably between Heads.

Significantly those with a wide past experience of committee work indicated that these experiences and contacts enabled them to gain wider access to information under the new system. One such Head was concerned that the introduction of middle management had resulted in inequality of opportunity for Heads of Departments to reach the ear of top administration. His position was that without his contacts he would not have known how or where to go for information of a type inappropriate to the role of his PVC.

5. Costly Items Joint Facilities and General Staff

(a) It was observed that "the fairly formal structure for costly items has disappeared somewhere" and that a series of judgments needs to be made about the replacement of or initiation of a proposal to buy high cost equipment. This was felt to be particularly important when the use of such equipment crossed group boundaries. Biotechnology was cited as an eight-department co-operative venture that cut across resource groups. It was suggested that "there's some very woolly administration in that supra-group area at the moment".

(b) The question of joint facilities e.g. Electron Microscope was raised as a potential problem as "users have little say in how it's run or what resources go into it." It was suggested that, the information that flows from UNITS such as this to Departments, should be improved.

The question of refurbishment and costly items was raised in several interviews as was also the policy governing the allocation of Technical Staff. It was suggested that the aggregate general staff resources would be more efficiently deployed in a Group basis "instead of each department operating as a miniature corporate administrative entity regardless of economic viability - a situation which either duplicates resources or penalises small departments if resources are allocated on a teaching staff numbers basis."

6. Solidification of Groups

This concern is best portrayed by the following extract from a written communication.

> "The major potential disadvantage of the new structure is the possibility that the group will 'solidify' with the departments within each group vying for the resources totally within the group. There needs to be a mechanism whereby there can be a transfer of resources from those groups which are well-endowed to those which are under-endowed. In many ways this problem stems from the current inability of the university to determine a series of specific goals, objectives, and priorities for the University, and then to set about achieving those objectives. This problem is of particular concern to expanding departments with the difficulties of achieving increased resources at a time of generally diminishing university-wide resources. The move to groups is a significant improvement as the previous situation which required the Head to deal with a variety of individuals and committees had become unworkable."

7. Timescale for Restructuring

Several Heads indicated the need to allow the new arrangements to shakedown,

> "I believe that it will take up to five years for new policies and procedures to be worked out, and the new system evolve into an efficient form of University administration. This can be seen in the current budgetary arrangements, where no department is currently sure of how to frame its budget, or to go about the ´politics´ of the budgeting process."

The strength of feeling in some quarters on this issue may best be illustrated by quoting the followiwng communciation

> "Although we have great sympathy for your project and can understand the reasons for surveying reactions to the latest University re-organization my Department does not wish to participate. The greatest concern for my Department, Faculty and Group is the dreadful possibility of a further re-organization which your survey findings might provoke."

8. Cross Group Initiative

Some Heads indicated uncertainties they perceived with respect to inter-Department activities that crossed group boundaries. One example involved a joint research submission which ran into problems because it was not resolved which group(s) was responsible for the necessary cross group funding of the project.

> "Grant giving bodies for years have stressed the need for interdisciplinary research. With research across groups who is responsible for resource implications. Is there any way to work out the percentage responsibility of the Departments and hence of the groups? This should go to the PVC committee."

Similar sentiments were echoed by another Head in the context of inter-disciplinary studies

> "I´m sorry to see that interdisciplinary courses have been eroded - to a large extent because of the difficulty of distributing the resource costs to the contributing Departments."

A third comment spoke of similar questions in relation to joint honours programs mounted by Departments in different groups.

9. Role and Functioning of Committees

This was the area (along with Faculty structures) most often raised by Heads of Departments and their concerns embraced two emphases

(a) the present status and role of committees which continue to exist in name but whose purpose seems to have changed under the restructuring.

(b) the nature and places of central decision making under the new structure.

Several comments expressed severe displeasure at a perceived downgrading of the Academic Board.

> "I think the relationship between the Academic Board and the Senate is something that worries me more than any other thing in this University. It allows for manipulation by collusion."
>
> "People in high positions say things that continually undermine the authority of the Academic Board."
>
> "Senate should be a house of review to send things back - not a house of veto. I've seen signs of an implicit (sometimes explicit) threat from members who don't like the way the Board voted along the lines of 'Well say what you like, this is going to Senate and Senate will vote differently and that will be the end of it."

Other comments simply expressed doubts about the revised roles of committees.

> "One of the real mysteries of the new system is what the Standing Committee does."

Still others expressed some mystification as to why the restructuring involved an uncomfortable mix of new structures and old.

> "Having got rid of sixty odd Departments going to Standing Committee for staff we still need to individually list and send to central a request for a single item of furniture."
>
> "We still have two persons to approach for resource allocation,
>
> Deputy Vice-Chancellor (Fabric and Finance) for space, minor works etc
> Pro-Vice-Chancellor for other."

With respect to (b) considerable concern was expressed in relation to the Academic Resource and Planning Committee (ARPC). This was perceived in several Departments as a somewhat secretive committee whose operation remained cloaked in mystery.

(It was clear that even the composition of the ARPC was not known by several Heads.) e.g.

> "I don't believe ARPC is functioning as it should. What has it done? What information have they got? Maybe they need to do some publicity work for people like me so we know what they're doing."

Similar comments arose elsewhere

> "I don't know what ARPC talks about - perhaps major academic developments are, in fact, being discussed in ARPC but I don't see much evidence of that"
>
> "The remoteness of the ARPC - we don't see the minutes so how do we know the basis of their decisions."

DEANS AND FACULTIES

Heads of Departments and Deans did not perceive that personal relationships between them had been affected by the re-organization. However there were many comments on the Faculty structure and role of Dean in relation to the Group structure and on this issue the views of Deans and Heads of Departments showed some divergence as well as some agreement. One fact that clearly emerged was the different issues encountered because of the different natures of the faculties.

> "I think the faculties have to accept that there are certain activities (responsibilities) which they no longer have."

> "The intermingling of the provinces of the Pro-Vice-Chancellor (resources) and the Dean (academic matters) makes it impossible to separate the two entirely. The chief disadvantage of the faculty structure within the restructuring is in creating more administration work."

> "The time is coming when people are going to say that this expedient of retaining faculty structure with group councils - this expedient was just an expedient and we're going to have to bring the two together. More and more people are saying this and some said it from the outset."

> "Academic planning (as distinct from degree administration) has become pretty much a grey area between faculty and group council. Faculties are more democratic allowing anyone in the university community to debate issues where the group councils are more exclusive. However the democratic forum isn't working very well because of the poor attendance at Faculty meetings."

> "The major thing that needs to be done given the weakness of the Faculty is to transfer academic power to the group council. Actually academic matters are being treated quite directly by our group council - and indirectly all the time" (An example cited was money for academic seminars not organized through the faculty)

> "There is no more problem than there's always been with faculty structure. Our faculties have never had much influence on the resource allocation side. Since Deans are on the group council they can put the faculty's view where

relevant so there's no problem there."

"In this group the Deans have in a way more power as the Pro-Vice-Chancellor with two Deans forms a kind of group executive which works reasonably well."

"If the University is going for some kind of middle management then they should strengthen the power of the Deans. The Dean should function through committees with Heads of Departments - the academic focus and the resource focus should be integrated."

"The Dean should act on a group executive - our group and faculty structures are very close."

"Academic leadership should come from the Deputy Vice-Chancellor (Academic) and Deans and related staffing and resources should be administered through the Deputy Vice-Chancellor."

"Deans and Pro-Vice-Chancellors should be amalgamated into super deans."

One Head expressed annoyance that the Dean's presence on selection committees had no value in many cases due to his unfamiliarity with the particularities of the Departments.

These comments initiated by Heads of Department contain no single message. For the most part they concentrated on the role of faculties (while also making references to the Deanship).

The comments initiated by Deans tended to reverse this emphasis with more concentration on the purpose and functions of the Dean.

PERCEPTIONS OF DEANS

1. Effect of Restructuring upon Faculties

Opinions varied from almost no effect to considerable effect reflecting, perhaps, the nature of different faculties. The main points raised involved changes in jurisdiction and in administrative work.

> "Faculty is well represented on group councils - its role hasn't diminished at all. The main threat to the faculty's standing is the apathy of its own members in coming to faculty meetings."

> "There has been considerable impact on faculty by altering the traditional mix of departments in this field. Formerly faculty handled research, equipment money and maintenance funds and this is now out of its province. While faculties are still called on to determine priorities in academic developments (e.g. courses or chairs) their determination has only a small impact on eventual outcomes because group councils decide funding questions. This is an unfortuante separation of responsibilities."

> "Biggest change is in decentralization. There are more meetings to attend but you know what's going on in other departments which is good - before you tended to be isolated."

> "In terms of daytime hours the Deanship would take up about 80% of my time (I expected about 50%). There is also a big call to serve on outside bodies which to some extent is a measure of the size and importance of the faculty."

2. Relationships with Heads of Department

It was noticeable that when Heads commented on this topic their remarks in the main centred on the personal relationships between the individuals. The Deans on the other hand emphasized far more the professional relationship between the positions.

> "There has been a very important change. Departments now see a need for a champion in the academic field. Departments use the Deans as support mechanisms to deal with Pro-Vice-Chancellors. In some groups the Deans sit on group executives and budget committees and so make major decisions on Departmental budgets, special projects and Special Study Leave programs. This is a very important new role for the Dean."

> "Yes there has been a change. Heads now have to divide their loyalties and attentions. One day they are with the Dean to discuss the development of a new discipline - next day they are with the group finding out whether the proposal can be funded. For the convenience of group management the best organization of educational objectives has been abandoned."

3. Contribution to Group Decision Making that extends influence beyond Faculty Departments

The clearest example of such an influence is a group in which the Deans, together with the Pro-Vice-Chancellor, form an executive that makes resource decisions affecting all Departments in the group. Various comments were received pertinent to this aspect of a Dean's role.

> "I'm on a number of committees e.g. SSP committees and Research committees where I provide information, opinions, and vote if appropriate."

> "The Deans in my group give a more dispassionate objective approach than Heads of Departments. We're a moderating influence. Each Head pushes his own barrow and its natural for a Dean to take a more objective view. It's also easier for a Dean to speak for or against Departmental submissions as a Head is aware of competition and may feel he compromises his own position by supporting or opposing other Departments submissions. This is a very distinctive role and I think every Dean sees it that way."

4. Achievements of the Group Structure

As to be expected the Deans were in general less acutely affected by interaction with Pro-Vice-Chancellors than were Heads of Departments. Their reactions could be partitioned into positive responses, and areas of concern which ranged from direct effects (such as work loads) to wider matters of principle to do with the functioning of the University.

Positive responses encompassed the enhanced role of Deans in resource decision making processes at group level and the increased efficiency of some decision making due to the group structure. It is interesting to compare the comments of Heads of Departments who commonly saw the powers of faculties reduced and the views of Deans who saw their roles on group executives etc as providing them with more influence than previously. This seems due to Heads continuing to view Deans largely in relation to administration of courses and students whereas Deans perceived their influential role in terms of their capacity to assess Departmental submissions in a disinterested manner at a resource decision making level.

5. Concerns Generated by the Group Structure

a. Workload

> "It's (the Deanship) a very effective role as one responsible for academic developments but the increase in additional administrative work has been enormous - I estimate an extra 40 to 50 additional meetings a year. While it was intended that Deans make a strong input into respective groups the additional burdens implied were not understood. For example I attended three committees where

the same material was argued - a faculty committee, then the corresponding group committee and finally the group council."

"I believe the efficiency that has been gained by having the pro-vice-chancellors concentrate on the use of resources has been greatly diminished by the additional work thrust on Deans, Heads and other committee workers. The ramifications of the extended committee structure produced by the additional tier of administration was never understood."

b. Blurring of Distinctive Faculty Properties

"In the past, faculty structure distinguished between clear professional faculties and those with widely dispersed interests and subjects. The new structure seems to have included an attempt to reduce that difference and make all faculties seem much the same. The responsibility of some faculties to the wider society seems to have been forgotten and the notion around at the time of re-organization that the deanship might be a part-time commitment is amazing to contemplate. The task is quite overwhelming and I think this points up an error in the original planning."

"A question has come up about the line of consultation and responsibility for Deans compared with the resource group structure. Originally Deans were to be responsible directly to the Deputy Vice-Chancellor (Academic) for non-resource academic responsibilities. Consulting with the pro-vice-chancellor was related to how new proposals could be funded from the group. Now there seems to be an attempt to blur this and to say that Deans are responsible on academic matters first to the pro-vice-chancellor which diminishes the line of command on academic matters to the top of the University. Some recent writings including Academic Board papers seem to confirm it as a quite important change."

c. Clashes between Resource and Academic Planning

"Seriously there are so many times when the system does not work. For example academic decision making often has resource implications and we make them knowing full well that we don't have the responsibility for them. Departments increase practical work here and there which will increase resource needs and its done at Faculty meetings. After such decisions have been made it's hard for a pro-vice-chancellor to tell a faculty of well over 100 people to go back and start again."

"You are seeing decisions made which will have resource implications - and major resource implications - and the people who make the resource decisions are not involved in the first decision. That's happening right across the University - its not limited to (my) faculty. A Dean cannot say to a Department 'you can't do that because it will cost the group more money and we're not going to give you more money.' He has no power to say that but that's what he should be saying."

"The main problem is artificial separation of resources asnd academic matters. Pro-Vice-Chancellors and Deans should be combined in some way. If you had, say, nine full time Super Deans with academic and resource power I think the University would work much better. At the moment the workload of Pro-Vice-Chancellors is much less than Deans."

d. Role of Central Committees

"The Academic Board has been emasculated to some degree by the mysterious Academic Resource and Planning Committee (ARPC) that obviously has great powers but doesn't seem to be established by Statute, described anywhere, and seems to be understood only by those who sit on it."

"It (ARPC) has become the most important sub-Senate part of the University's decision machinery, and I don't know anything about it - or far too little - for what is clearly a vital part of the system."

"I worry greatly about the function of ARPC. Pro-Vice-Chancellors are making subjective decisions to look after their own groups and often they're wrong decisions. There's something wrong with the way decisions are made."

"You need something like ARPC - what is the point of the Academic Board? - its influence has lessened. It's only advisory and its advice can be ignored."

"I don't want to have to fight against any attempt to make the groups a series of mini Universities. You need a cohesive whole but somewhere centralisation must give way to decentralization."

"The admissions procedure is more cumbersome than I would like e.g. procedure for referring miscellaneous students or special admissions are too involved and cumbersome. My preference would be for such decisions to be the province of Faculty."

Suggestions for improving the functioning of the University as seen by Heads and Deans are implicit in many of the comments included in the preceding sections. Three basic positions seemed to underpin the emphases provided by the interviewees. These related to whether the individual had strong feelings for or against the restructuring. One submission strongly urged a return to what was essentially the former system. One or two strong supporters of the new structure were very positive with an occasional reservation. The remainder generally reacted in a mixed way with recognition of perceived improvements and reservations about perceived deficiencies. Almost all suggested some structural amendments or a clarification of procedures and roles in certain areas. The general flavour of comments appeared to vary with the level of outside funding available to the particular Departments. Those who received most of their money from external grants appeared to be more impatient with the new system than those relying more heavily upon group resources. This was because increases in administrative loads and perceived lack of clear avenues for some decisions were more annoying when the associated resources were seen as marginal in the total context of the Department.

From an overview of the reactions a number of observations can be made.

i. The very clear improvement in some areas of decision making makes for extra sensitivity to perceived deficiencies elsewhere. The appreciative remarks about resource decisions under the jurisdiction of the pro-vice-chancellors stand in contrast to comments on matters that were seen to lack a similar decisiveness. Heads of Departments collectively defined several areas where they felt the decision making procedures were either inadequate or not sufficiently explicit. These areas included.

General Staff	. Refurbishment	. Costly Items
Minor Works	. Space	. Furniture

Decisions on tenurable appointments and Chairs
Resource allocation to cross group enterprises.

ii. Both Heads of Departments and Deans spoke of the need to align resource allocation and academic planning more closely. In the majority of cases the faculty and group structures were seen as uncomfortable bed-fellows.

iii. A very definite need was seen for the clarification of the roles of central committees outside the groups and faculties.

(a) Committees which retain their former titles but which have had their roles altered e.g. Academic Board and Standing Committee.

(b) New and important committees such as the Academic Resources and Planning Committee.

It was clear that Heads and Deans were uncertain about the actual scope of the powers of such committees and that they felt disadvantaged because of this. Better channels of information would have been greatly appreciated.

iv. There has clearly been a great increase in the administrative load at all levels of the University. It has not been obvious from any interview that administrative loads have been lessened as distinct from altered. Mention of duplication, proliferation of meetings etc. suggests that the effectiveness of the restructuring is uneven. The efficiency of centering certain decision making with Pro-Vice-Chancellors and Group Councils needs to be matched in other areas of the structure.

v. The co-operative/competitive balance between resource groups and between departments within resource groups is clearly a delicate issue.

Within the competitive framework two elements of resource allocation at group and department level were in evidence as unsolved problems.

(a) How to arrive at figures for cost/student ratios within the variety of departments and groups?

(b) What planning mechanisms will enable resources to be acceptably shifted across departments and between groups as needs and demands change?

PART 2: THE RESOURCE ALLOCATION MODEL

The preceding sections have sought to identify successes and concerns associated with the restructuring and have pointed to some areas that should be considered in a review of the whole. The data discussed in the earlier sections of this report can be considered as encompassing two main themes. The first theme has to do with the operational structure of the university and its effectiveness across the university community.

The second theme encompasses decision making principles as distinct from decision making procedures and machinery. The question remains as to what principles of resource allocation are most appropriate in a competitive system, where needs and demands in different parts of the system change with time. From comments by members of each of the groups that were interviewed, the competitive aspect, is clearly a dominant feature. Heads of Departments and Deans referred to the competition of departmental submissions at Group Council level. Pro-Vice-Chancellors clearly relayed the same message with respect to competition between resource groups.

> "There will be competition between Group Councils to right traditional wrongs."
>
> "We all recognize that when it comes to resource change decisions for next year the Groups must be weighted against each other."
>
> "We clearly have to work out some way of shifting resources to take account of planned decisions and developments".

Not explored in detail in this project is the competition for resources between centrally funded authorities, such as the Library and the academic resource groups.

A Resource Allocation Model

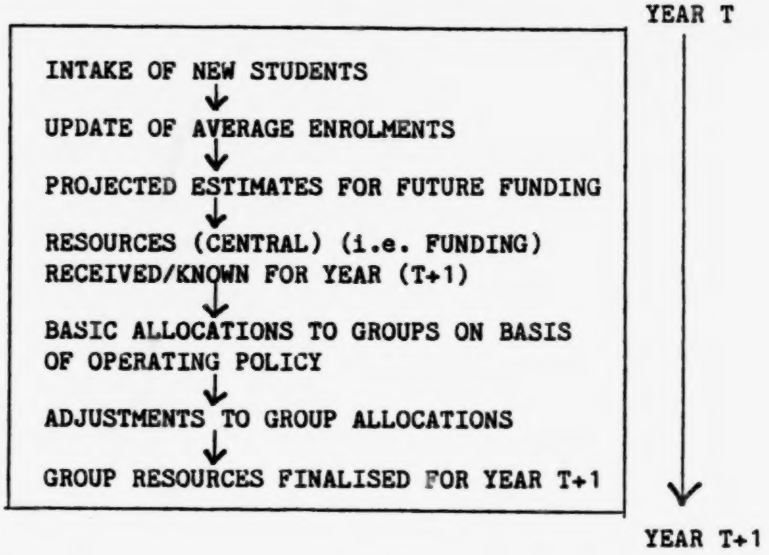
Resource Groups as competitive operations have a generic component, in the sense that, different situations contain the same essential structure although they vary in detail. The allocation model describes a situation in which several groups compete for resources from a central source. As needs within the groups change, in response to influences from their environments, the balance of relative advantage/disadvantage varies. The purpose of constructing the dynamic model was to explore the effects of alternative policies with a view to identifying those policies that appear more effective in achieving satisfactory group performance. In its present form the model is written in such a way as to portray the competition between a set of resource groups for available central funds. With minor adjustments, the model also describes the interaction of individual departments within a resource group.

Since the purpose of the model is to describe the characteristic behaviour of a system of competing groups, the precise number of groups is not of great importance. The simplest system that contains the necessary competitive structure, is a three group system. Adding more groups serves only to add parallel structure with additional detail resulting only in greater complexity. No additional behavioural characteristics are generated as can be inferred from the feedback structure which includes all distinctive loops within the three group system.

Model Structure

The model describes a system of resource groups that compete for central funds, subject to variations in student demand and within-group costs, as well as variations in the quantity of central resources available. At the beginning of each calendar year, the student population is augmented by a new intake that can be adjusted to reflect varying enrolment policies, based on resource/student ratios. Average enrolments are then updated and form the basis for future funding applications to the Federal Government. Funds in the form of central (controlling) resources are received. The actual amount is determined by projections from past average enrolments modified by external policies that the government may choose to impose. Provisional allocations are made to the Groups on the basis of their projected enrolments or according to one of the several alternative policies provided for in the model. If the central funds made available to the groups have been cut (or augmented) from those planned for, or if changes in enrolment patterns have occurred, the basic allocation may over-allocate or under-allocate the available resources. In this situation an adjustment is made to the Group allocations so that all funds are committed. The adjustment procedure may be based upon alternative criteria, such as proportional enrolments or proportional group disadvantage. The Group disadvantage is calculated in the form of a ratio each year in terms of group resources and average enrolments. The Group funds now allocated form the resources for the following year, when the cycle begins again.

The following timeframe shows the chronology of the real world events that are contained in the model structure.


YEAR T
INTAKE OF NEW STUDENTS
UPDATE OF AVERAGE ENROLMENTS
PROJECTED ESTIMATES FOR FUTURE FUNDING
RESOURCES (CENTRAL) (i.e. FUNDING) RECEIVED/KNOWN FOR YEAR (T+1)
BASIC ALLOCATIONS TO GROUPS ON BASIS OF OPERATING POLICY
ADJUSTMENTS TO GROUP ALLOCATIONS
GROUP RESOURCES FINALISED FOR YEAR T+1
YEAR T+1

In sifting through the many interview comments that referred to Group inequities, it became clear that significant differential changes in student numbers is a recognized basis for agreement on the need to redistribute resources. Increases in student numbers, without a commensurate increase in funds, had caused severe stresses within two of the Resource Groups in 1984. Alternatives to additional Group resources, or the application of strict quotas with their implications across the University were raised as seemingly inevitable consequences. Some equivalent of the concept of student/resource ratio clearly underlies thinking that compares resource groups with respect to funding adequacy. A rapid rise in student/staff ratio, followed by a persistence at the higher value, has been the background for comments relating to emerging inequities. Similarly, the admission that a reduction of student numbers over time will reduce resource claims, is connected to the overly favourable student/resource balance that would otherwise occur. It is noted that the question of COST/WSU in different groups and departments is a continuing issue as technology changes the traditional cost weighting associated with certain courses.

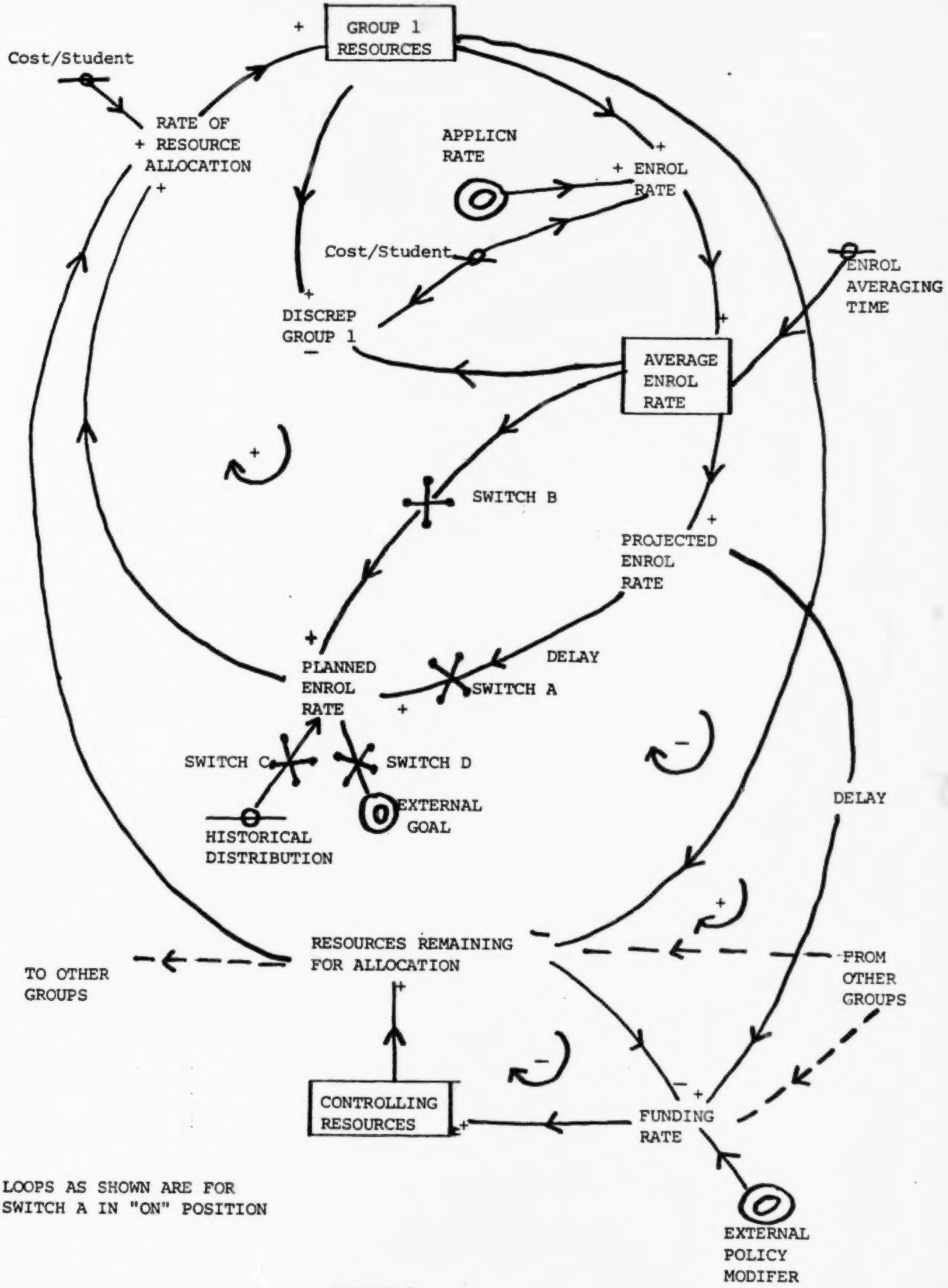
It is an assumption that elasticity is an important property of a system variable, such a student/staff ratio. Such a variable fulfils an important role in that it behaves as a "shock absorber." Rigid quota systems can always be devised to constrain enrolments to within a pre-determined upper limit. However the flexibility of a system in responding to new enrolment trends, and in particular, in recognizing the need to distribute resources away from a declining area, is inhibited by too much control. A major achievement of a resource allocation mechanism is to be able to damp down extreme variations in variables such as student/staff ratios that occur as a result of student enrolment surges. This amounts to devising policies within which, elasticity is retained, but which control the variations endogenously. Since Group resources include, but go beyond staffing, the concept of student/resource ratio is introduced as a more general concept than student/staff ratio.

Causal Diagram

Figure 1 contains a causal diagram for the model structure. For simplicity only group 1 variables are shown and where applicable links from other groups are shown by means of broken lines. The policy switches represent decisions made by policy makers and activate criteria for alternative resource allocation mechanisms. They are not switches that are activated by system conditions during the course of a simulation. The loop structure of Figure 1 that is amplified in Figure 2 (a) - (d) describes basic allocation procedures. Other links become operative if the concept of an adjustment allocation is introduced. Adjustment allocations can take the form of supplementary funding as might occur if additional funds are made available, or cuts in funding if less funds are received than were planned for.

A detailed discussion of the major model equations is provided in Appendix B and complete model documentation in Appendix C. A description of the main structure shown in the causal diagram now follows.

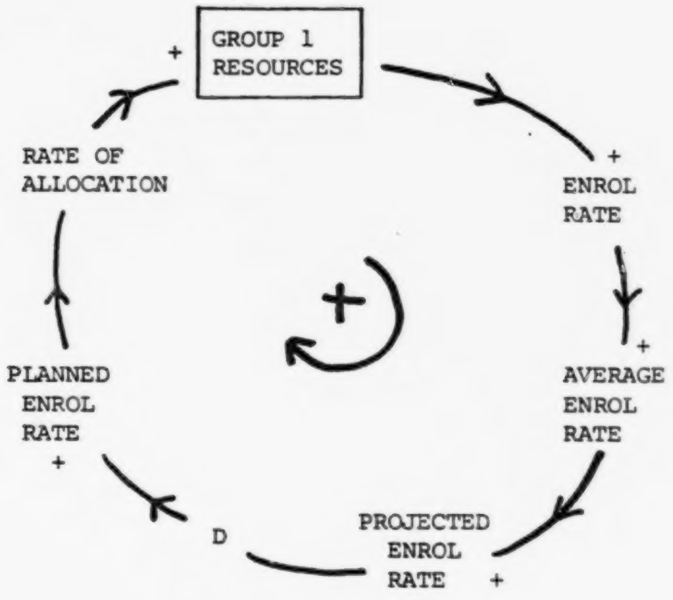
The APPLICATION RATE is defined in terms of the qualified applicants seeking places. To provide for a variety of input conditions a range of options is made available in this exogenous factor. Provision is made for the application rate to include conditions of


GROUP 1 RESOURCES
Cost/Student
RATE OF RESOURCE ALLOCATION
APPLICN RATE
ENROL RATE
Cost/Student
DISCREP GROUP 1
ENROL AVERAGING TIME
AVERAGE ENROL RATE
SWITCH B
PROJECTED ENROL RATE
DELAY
PLANNED ENROL RATE
SWITCH A
SWITCH C
SWITCH D
HISTORICAL DISTRIBUTION
EXTERNAL GOAL
DELAY
RESOURCES REMAINING FOR ALLOCATION
TO OTHER GROUPS
FROM OTHER GROUPS
CONTROLLING RESOURCES
FUNDING RATE
EXTERNAL POLICY MODIFER
+
−

* LOOPS AS SHOWN ARE FOR SWITCH A IN "ON" POSITION

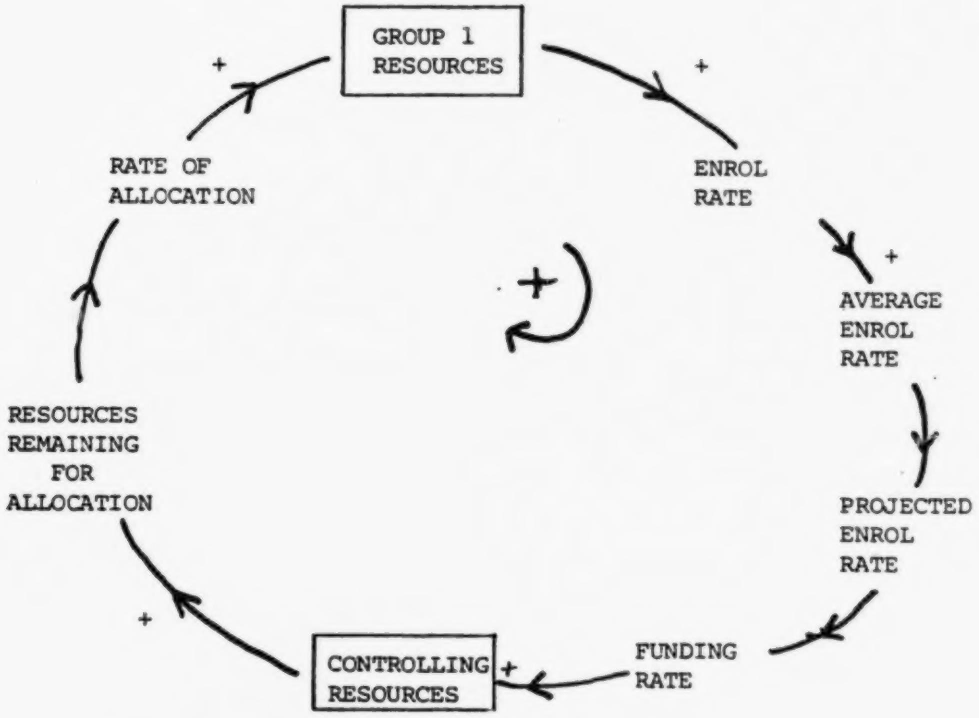
FIGURE 1

(a) **Demand based loop - allocation process**



GROUP 1 RESOURCES
+
ENROL RATE
+
AVERAGE ENROL RATE
+
PROJECTED ENROL RATE
+
D
PLANNED ENROL RATE
+
RATE OF ALLOCATION
+

(b) Demand based loops - funding



GROUP 1 RESOURCES
+
ENROL RATE
+
AVERAGE ENROL RATE
PROJECTED ENROL RATE
FUNDING RATE
+
CONTROLLING RESOURCES
+
RESOURCES REMAINING FOR ALLOCATION
RATE OF ALLOCATION
+

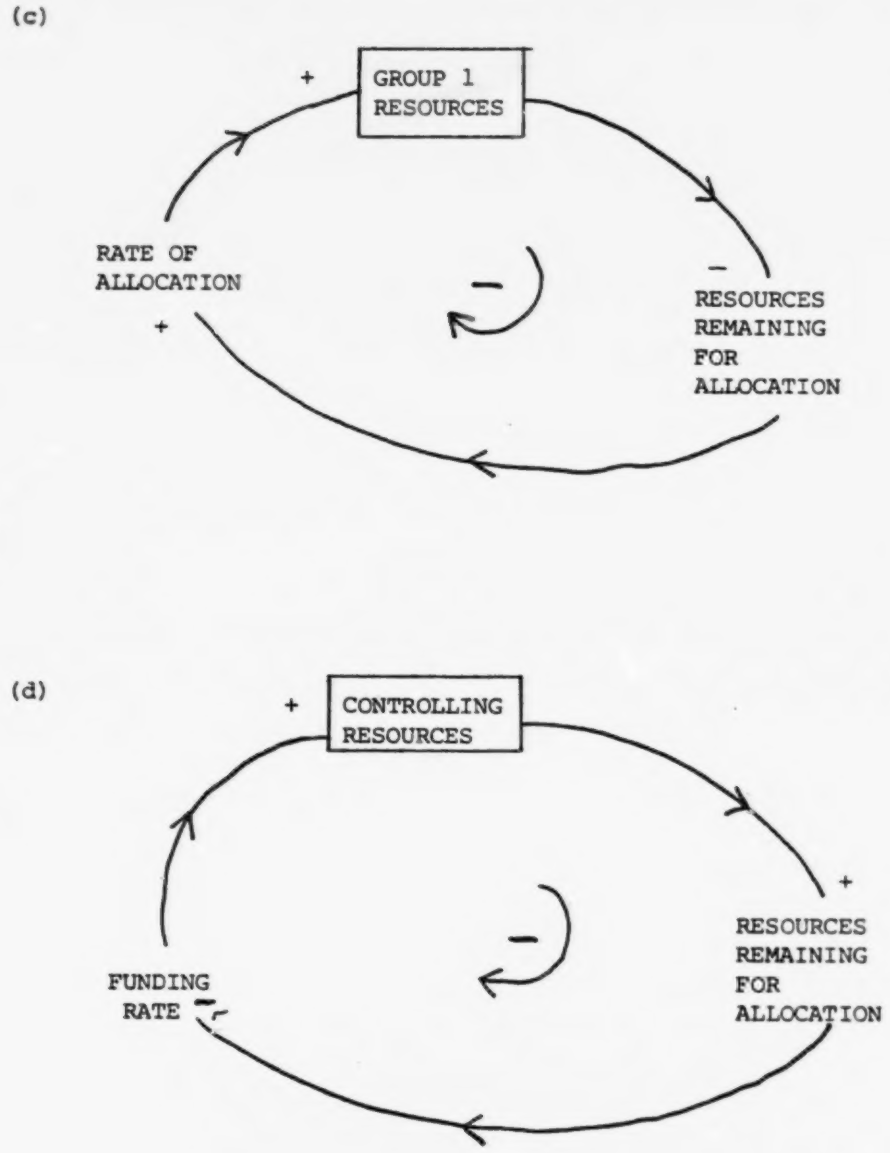

(c)
+
GROUP 1 RESOURCES
−
RESOURCES REMAINING FOR ALLOCATION
RATE OF ALLOCATION
+
−
(d)
+
CONTROLLING RESOURCES
+
RESOURCES REMAINING FOR ALLOCATION
FUNDING RATE
−
−

Fig. 2

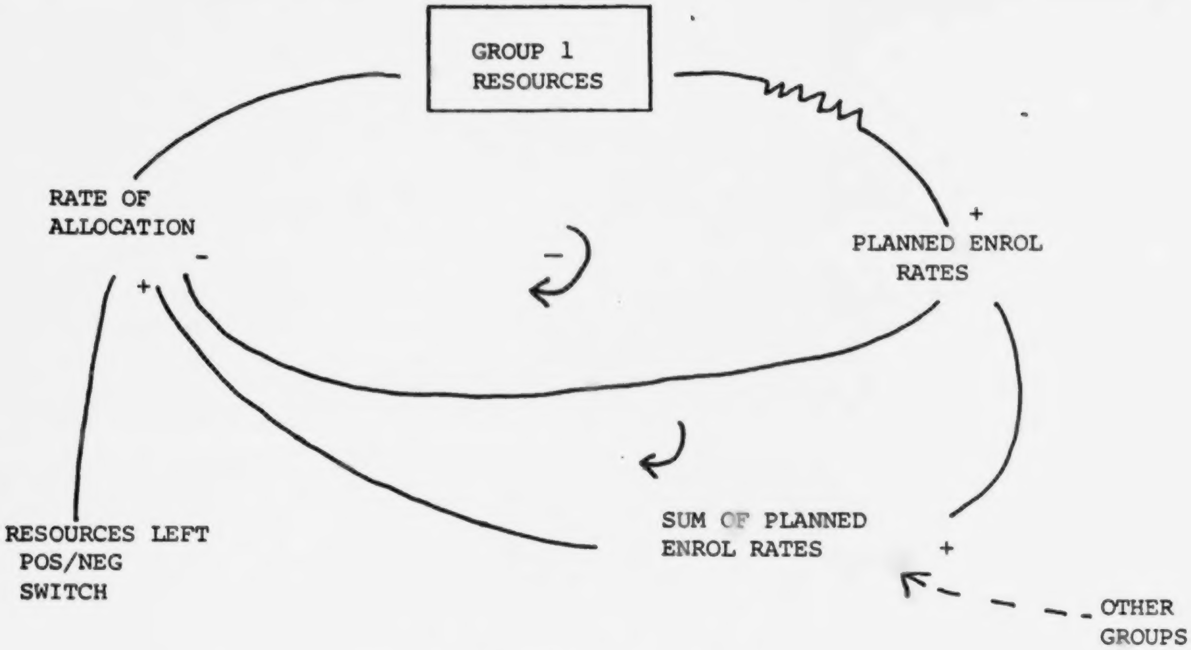

GROUP 1
RESOURCES
RATE OF
ALLOCATION
-
+
−
+
PLANNED ENROL
RATES
RESOURCES LEFT
POS/NEG
SWITCH
SUM OF PLANNED
ENROL RATES
+
OTHER
GROUPS

Fig. 3

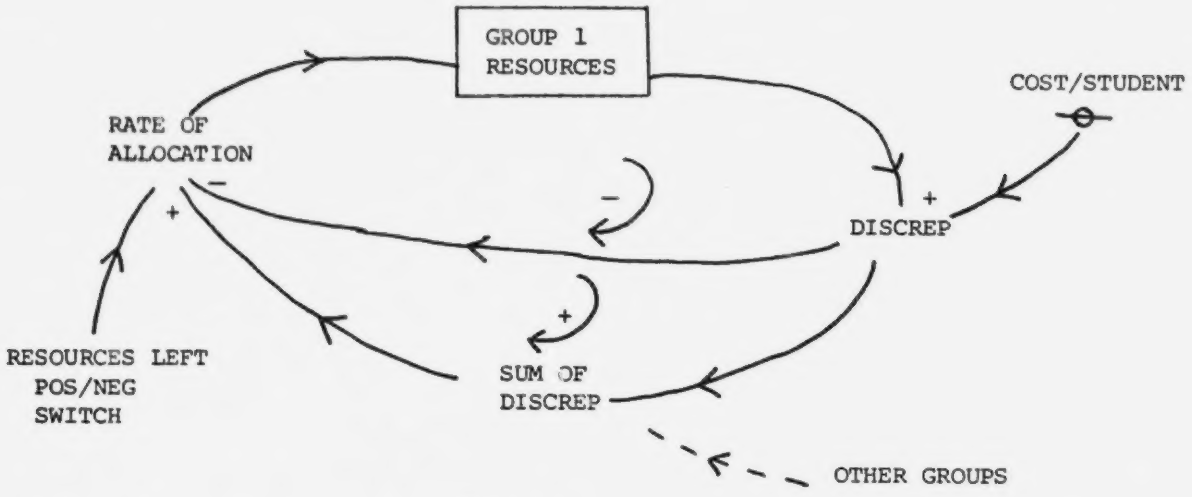

GROUP 1 RESOURCES
COST/STUDENT
RATE OF ALLOCATION
−
−
+
+
DISCREP
+
RESOURCES LEFT POS/NEG SWITCH
SUM OF DISCREP
OTHER GROUPS

Fig. 4

(a) steady intake and/or shock

(b) exponential growth

(c) periodic(sinusoidal) variation

(d) generalised table input

The ENROLMENT RATE describes the entry of those students accepted into courses. It is expressed as the minimum of the application rate and the maximum number of students that the faculties are prepared to accept. In equilibrium the COST/WSU has the accepted "normal" value for the appropriate department or group. If the average amount of money available per student is less than this, then enrolment will be higher than "normal" relative to the resources. As the average cost/student decreases it means that available resources are being spread increasingly more thinly, which will be associated with a reduction in the quality of education and a rise in staff work loads. (For this purpose all resources are aggregated). A critical value of COST/WSU exists which provides an absolute quality cut off. If this critical value is reached, there can be no further enrolments unless the resource position is improved. Under normal applicant pressure (except in courses with rigidly enforced quotas), students are enrolled and the average COST/WSU ratio allowed to drift downwards. This downward drift is also evident by a corresponding rise in student/staff ratios. When the critical value is reached an enrolment limit is imposed unless further resources become available. In a situation of declining enrolments all applicants can be accepted and in some cases the cost/student ratio will be more favourable than the "normal" value. These conditions will make the Group relatively favoured and render it vulnerable to having resources taken away from it.

Since COST/STUDENT (or COST/WSU) is a measure of the resources consumed in educating a student it will vary among departments and groups. The model variable is an aggregated representative value which can be regarded as typical of a Group. Provision is made for the "normal" value of the cost ratio to be varied between, and within, model runs. Step changes, exponential growth, and arbitrary table function changes are provided for.

The critical ratio (or Group discrepancy) measures the relative disadvantage/advantage of the Group. The equilibrium value is set at 1 when resources and enrolments balance according to the accepted "normal" cost/student applicable within the Group. If the average enrolment increases faster than the Group resources these resources become spread more thinly and the Group discrepancy takes values < 1 - a condition of disadvantage. Similarly values > 1 represent conditions of relative advantage with respect to "normal" conditions. The behaviour of the respective discrepancy variables are key indicators of the effectiveness of resource distribution policies.

The CONTROLLING RESOURCES represent the pool of central funds that are made available for competitive allocation to the Groups. They are generated by a FUNDING RATE and allocated to groups. The

FUNDING RATE is determined on the basis of the PROJECTED ENROLMENT RATE derived from enrolment data at an earlier time, modified by amendments that the funding authority may choose to impose (EXT). A variety of modifying options are provided for

(a) base allocation + step change
(b) exponential growth (or decline) of funds
(c) ramp growth of funds
(d) arbitrary table input to funding rate.

For example the step function provision enables the modelling of say a 10% cut or boost in projected funds. The ramp function is used to represent rigid goal-based funding, in which feedback from the existing system is overridden. Together with application rates and cost components the external policy modifier represents the exogenous inputs to the model.

PLANNED ENROLMENT RATE is the basis of the disbursement of basic allocations to Groups. It refers to the number of students for which the Groups are funded and can differ from the projected enrolment rates that form inputs for funding submissions. Some of the interview data refers to history or tradition in the allocation of funds to competing parties. Since this model seeks to inform as to the likely impact of policies, a variety of procedures for basic resource allocation are provided through switches A to D. This amounts to modifying the features of projected enrolments by e.g. using historical precedent or planned development in arriving at a final outcome for planned enrolments for a particular year.

Basic allocations of central (controlling) resources to the Groups are modelled to include the following alternatives

(a) distribution based upon historical precedent

(b) distribution based upon historical precedent modified by subsequent movements in average enrolments.

(c) distribution based upon planned enrolments in which the planned enrolments may themselves be determined by:

  (i) projected enrolments based upon the dynamic or moving history of the system

  (ii) goal based enrolments as when a period of planned growth is determined over time.

(d) distribution based upon current average enrolments

(e) a combination of several of the above

Feedback Structure

Figure 2(a)-(d) contain the most important loops that determine the behaviour of the model whose basic structure is represented in Figure 1.

Loop (a)

This loop contains the variables that form the basis of enrolment projections and future allocation mechanisms. An increase in enrolment rates in group 1 leads to an increase in the average enrolment rates observed as typical of conditions in the group. This increase, projects forward to increase the planned enrolment rate which leads to an increase in resource allocation and hence to the group resources. The increased group resources now tend to support a further increase in enrolment rates as the positive cycle is completed.

Loop (b)

This loop represents the mechanism whereby funding is related to projected student numbers. An increase in enrolment rates increases the average (observable) enrolment rate typical of the group, which tends to increase the future projected enrolment rate and hence the rate of funding as a future demand-based on projected numbers. (This demand based funding rate can be modified by the external policies of the funding body). An increase in funding rate increases the total amount of controlling resources available, and hence the amount of resources available for allocation to groups. This increase in turn increases the rate of resource allocation to group (1) which now tends to support a further increase in enrolments. This loop is also a positive cycle.

Loop (c)

This simple direct negative loop simply affirms that as group resources are increased, fewer central resources remain for allocation, and hence the rate of allocation is reduced. This in turn tends to reduce the amount of group resources as the negative cycle is completed.

Loop (d)

Loop (d) reflects the circumstances whereby unspent resources are "lost". An increase in the quantity of controlling resources tends to increase the amount of resources remaining unallocated. An increase in funds not spent, will in turn, reduce the rate at which funds are received and hence, to a reduction in the quantity of available controlling resources.

Note: Other loop structures become operative with the activation of various combinations of the switches A-D. Some such mechanisms are described in the discussion of model detail in appendix B.

Adjustment Allocations

As indicated previously if the available central resources differ in quantity from those planned for an adjustment to the basic group allocations will be necessary. Two alternative adjustment procedures are represented in Figure 3 and 4 based respectively of proportional criteria with respect to enrolments and group discrepancies.

Adjustment Loops

1. Enrolment based (sample loop): resources negative

If RESOURCES LEFT after the basic allocation is negative, then groups lose resources in proportion to the level of their planned enrolments. If the basic allocation is in terms of planned enrolments, then this represents a pro-rata reduction and could be considered a single resource allocation decision. There are however, other opportunities for adjustment e.g. by the use of reverse feedback. This would occur if having made the basic allocation on the basis of planned enrolments, it is argued that in any adjustment those with the largest basic allocations can afford the least cuts. This would distribute the resource-paring operation so that groups with larger numbers would take proportionately lower cuts effectively reversing the pro-rata mechanism. In either case the upper and lower loops have opposite polarity so that the loop that allocates in proportion to the weighted enrolment is undermined by the loop that weights the allocation according to the conditions in all groups.

If RESOURCES LEFT is positive then there is opportunity to recognize recent moves in group needs by distributing the excess in proportion to average enrolments. Average enrolment rates, and the sum of average enrolment rates should replace the planned enrolment rate variables in the loop structure. Again the feedback structure consists of two compensating loops with the net purpose of redistribution in favour of groups with increasing enrolments.

2. Discrepancy based (sample loop): resources negative

If RESOURCES LEFT after the basic allocation is negative then groups lose resources in proportion to the value of their discrepancy. This means the most poorly favoured group (lowest DISCREP) loses the least. In this case the upper loop is negative and its influence in favouring groups with low discrepancies is undermined by the influence of the lower (positive) loop in which the discrepancy contributes to a denominator factor in the proportional removal of resources.

If RESOURCES LEFT is positive then groups gain additional allocations in proportion to their inverse discrepancies. This ensures that the least favoured group receives proportionately the most in any further allocation. The loop structure when redrawn with inverse discrepancies and sum of inverse discrepancies has two opposing loops in which the effect of the loop that distributes in proportion to inverse discrepancy is undermined by the loop that weights the allocation according to the conditions in all groups.

Note: The polarity of the dual loops comprising the adjustment mechamism reverse according as to whether the resources remaining for allocation are positive or negative.

In the examples that we have shown, the basic allocations are assumed to have overcommitted the central resources that are available so that cut backs are necessary. With negative resources, an increase in the rate of allocation to a group is equivalent to a reduction in the amount removed. Hence in Figure 3 with a proportional policy based on enrolment size, increases in enrolments will lead to corresponding pro-rata reductions so the upper loop is negative. The effect is mitigated by the lower positive loop as discussed previously. (Similar arguments apply within Figure 4.) If additional resources are made available the pro-rata policy will favour the larger enrolments and the upper loop in Figure 3 will be positive and the lower loop negative.

Simulation Experiments

More than 100 experiments have been conducted with the structural model. These experiments have involved the combining of alternative cost and enrolment inputs with various allocation policies. In particular, the behaviour of the model has been examined under conditions of enrolment step changes (shocks), exponential growth, ramp growth and periodic fluctuation. A representative selection of model run outputs has been included for illustration. It should be emphasised that the wide variety of alternatives tested seeks to provide information on policy implications across a much broader spectrum of conditions than would pertain to any particualr institution such as the University of Queensland. It is noted however that essentials of the local situation are included in the simulation experiments.

It is not important that a dynamic model of this type should be initialised and parameterized with values that are numerically equal to those within the institution being modelled. Of much greater importance is the structural validity of the model. The model is started in equilibrium with a uniform application rate of 5000 students per group, or, in runs where application rates differ of

6000, 5000, 4000 students respectively. The "normal" costs/student are set at $500 when group costs are equal and $600, $500, $400 when the "normal" cost/student is assumed to differ according to group. A simulation time of 15 years has been selected although a 10 year period would have been adequate. The stability and behaviour of the model was tested initially by means of enrolment and cost shocks. This involved the introduction of step changes in application rates and in "normal" cost/student values within the groups after the model had been started in equilibrium.

The reference mode behaviour required to be replicated by the model is the sensitivity of student/resource ratios within groups to alterations in student demand. The model is shown to generate this mode of behaviour and is then used to test policies for their capacity to redistribute resources in response to changing conditions.

Step inputs (enrolment shocks) are used initially to test the stability of model behaviour. However, it is noted that while such inputs are typically used for this purpose alone, it also happens that the problem addressed by the model, is just that of a system, subject to surges in demand (positive and negative) distributed unequally across groups. Hence the model behaviour under enrolment shock provides useful information for policy evaluation in addition to its role in testing model stability. Again, it is emphasised that the output of dynamic models should be interpreted at the behaviour mode level rather than at the level of numerical detail. It is changes in the qualitative nature of the behaviour generated by a model as a result of altering policies, and the direction of the movement of numerical output that forms the basis for interpretation. The testing by shock inputs typically overstates the severity of similar effects when set in the context of actual real world conditions. It can be noted that the reduction of resources for a declining group will normally be damped by effects such as tenured staff commitments.

It was found that the relative characteristics of the policies are preserved when modest exponential growth, or ramp growth is used instead of enrolment shocks to generate student demand, and this consistency across a variety of input types is a key factor in both model and policy evaluation.

Basic Experiments 1-6

These simulate behaviour for a variety of policy mechanisms using step changes of enrolment rates to generate stress.

Additional Experiments A-H

These are representative of the range of experimentation conducted, with variation in both type of enrolment input and in basic and adjustment allocation policies.

Reading the Output

Of the many variables tabulated and/or plotted just six have been chosen for display. These are the values of the group resources and the critical ratios (measure of disadvantage) for each group.

GR1, GR2, GR3:	The values at t=T are the group resources for year T+1
CRAT1, CRAT2, CRAT3:	These variables measure the resource/student ratio in the groups for each year.

A brief description and interpretation of the output is provided for each run. Printouts of tabular output for 36 of the model variables are available from the authors. Many of these are redundant in that they have been printed out as checks that the model equations are functioning correctly, and they do not particularly illuminate discussion.

MODEL RESPONSE TO ENROLMENT SHOCK (1 - 6)

1. Basic Allocation Policy: Based on historical distribution with weighting for relative changes in average enrolments.
: Costs/student (normal) in all groups equal.

ENROLMENT SHOCK INPUTS

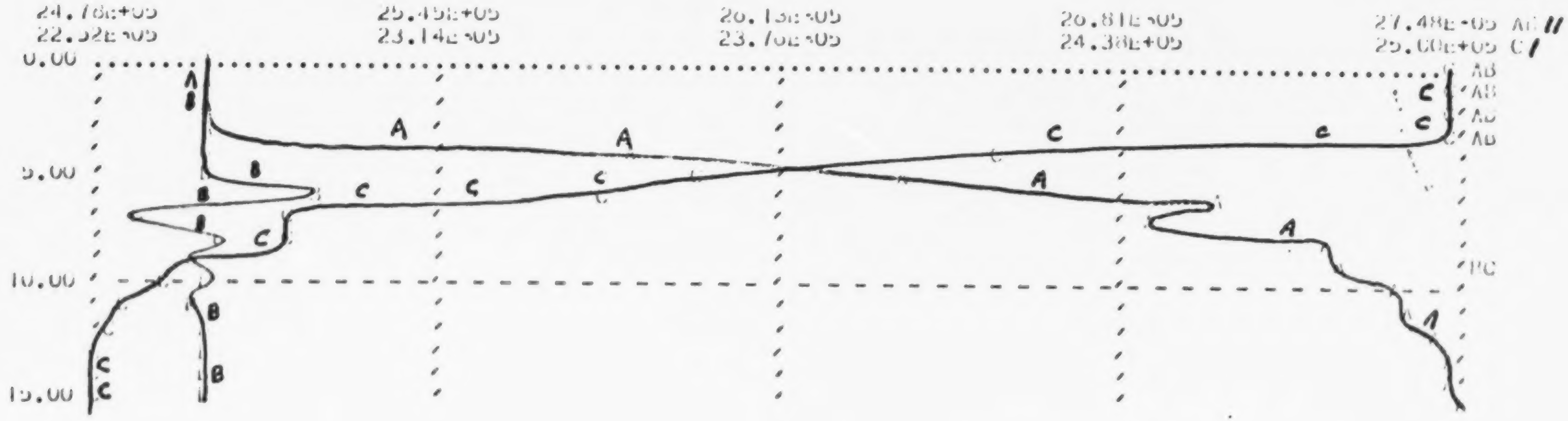
GROUP 1 : Step input of +20% at T=3
GROUP 2 : Step input of 0%
GROUP 3 : Step input of -20% at T=3

Note: Behaviour of model for a policy based on pure historical distribution weights is more extreme (unsatisfactory) than for this run.

85/04/24. SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD PAGE 12

UNI RESOURCE MODEL (ENROL SHOCK)

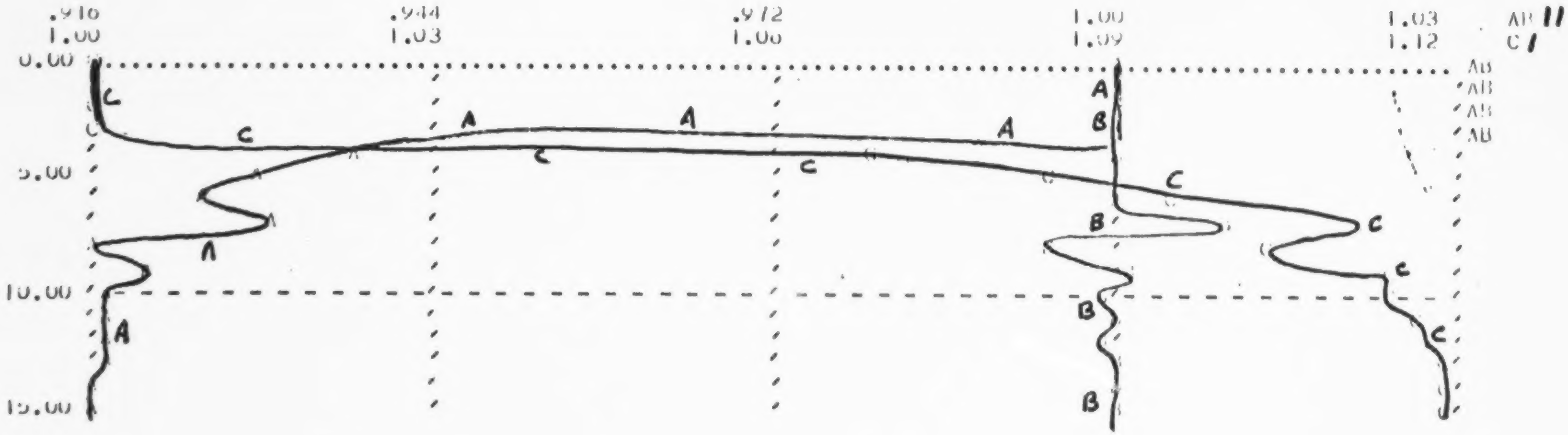
		MIN	MAX	PLOT INCH
UR1	= A —	25.0000E+05	27.4805E+05	2700.8
UR2	= B —	24.8708E+05	25.2222E+05	2700.8
UR3	= C —	22.5191E+05	25.0000E+05	2480.9



System moves to a new stable equilibrium by T=9 with some redistribution of resources to reflect differences in average enrolments.

BEST COPY AVAILABLE

```
85/04/24.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                    PAGE   15
 UNI RESOURCE MODEL (ENROL SHOCK)


                              MIN                      MAX                      PLOT INCR
          CRAT1    = A         .91587                   1.0000                   11.1978E-04

          CRAT2    = B         .99507                   1.0089                   11.1978E-04

          CRAT3    = C         1.0000                   1.1243                   12.4295E-04
```



Critical ratios alter in response to enrolment shock and settle (groups 1 and 3) to new values representing substantial advantage (group 3) and disadvantage (group 1). Group 2 value settles back to its equilibrium value. Typical of situation where e.g. staff/student ratios are quickly affected by an enrolment surge and then tend to remain at their new (higher or lower) values.

Situation is an improvement on the purely history based policy but the historical component continues to impede adjustment of the system. Some oscillation is induced in the group 2 variable due to system feedback. Policies with a commitment to traditional historical distributions are not successful in redressing imbalances induced by uneven student pressure.

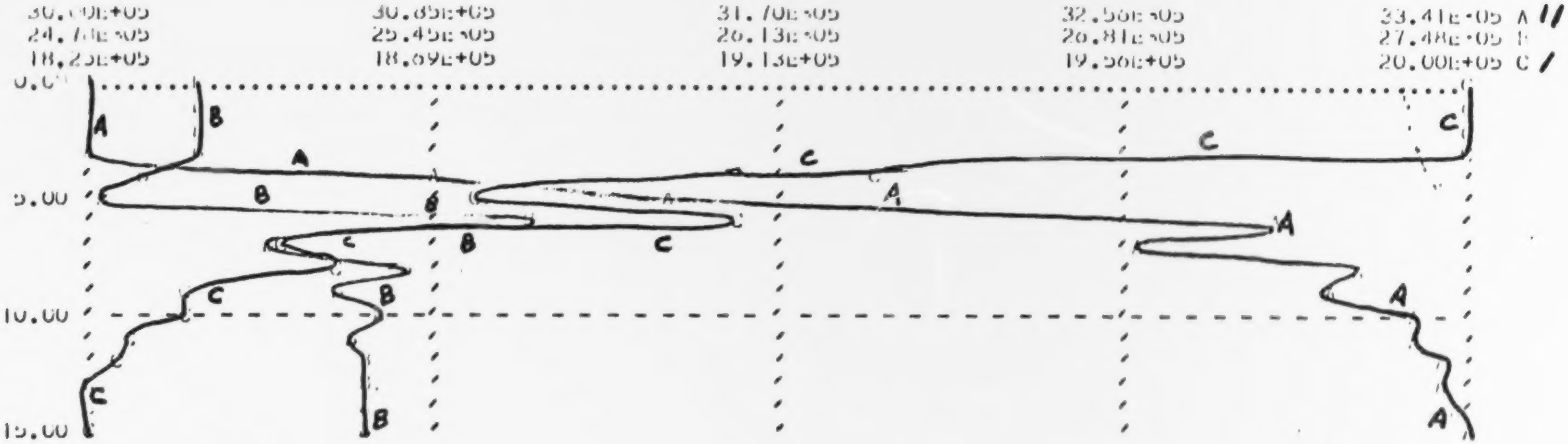
BEST COPY AVAILABLE

2. Parallel run to run 1 with "normal" costs/student different in the different groups.

group 1 : group 2 : group 3 = 6 : 5 : 4
costs costs costs

PAGE 71

```
85/04/24.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                        PAGE   20
 UNI RESOURCE MODEL (ENROL SHOCK)



                              MIN                      MAX                          PLOT INCR
        GR1       = A /      30.0000E+05              33.4072E+05                  3407.2

        GR2       = B |      24.8162E+05              25.6492E+05                  2700.8

        GR3       = C |      18.2505E+05              20.0000E+05                  1749.5
```



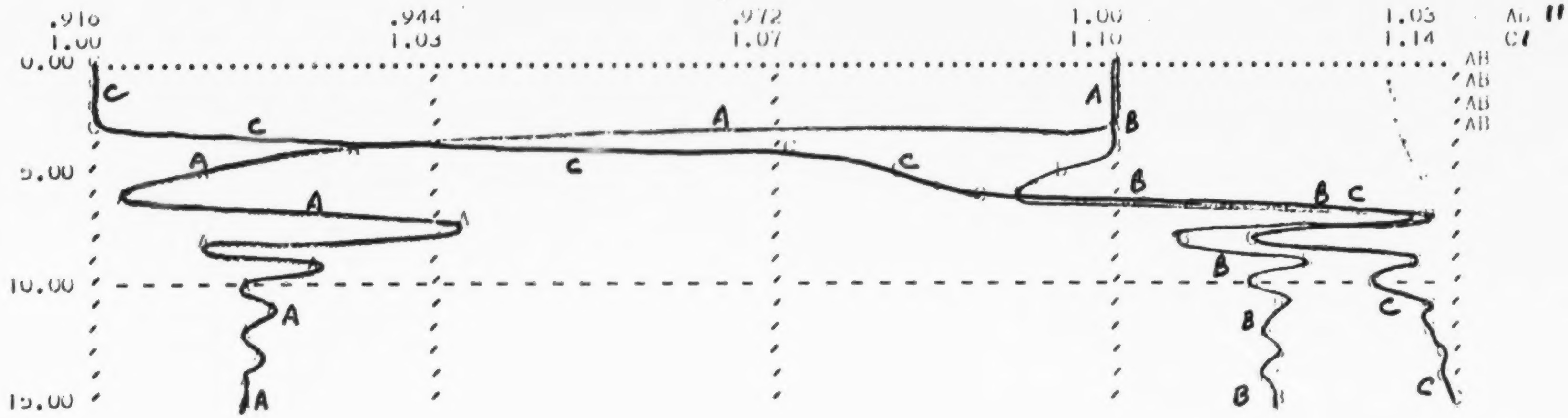
The essentially similar behaviour indicates that the model is not sensitive to differences in costs/student within the different groups. Other runs in which cost shocks rather than enrolment shocks were applied gave similar stable behaviour in all cases.

Hence differences in costs between groups contribute the expected variation to numerical values but do not change the nature of model behaviour and hence of policy implications. (True for all runs).

Variation in costs is not an important feature in later runs and whether they are set equal or unequal is at times a matter of coding convenience.

BEST COPY AVAILABLE

```
85/04/24.     /     SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD         .    .    PAGE   23
  UNI RESOURCES MODEL (ENROL SHOCK)


                            MIN                  MAX                    PLOT INCR

      CRAT1    = A           .91852               1.0000        .         11.1978E-04

      CRAT2    = B           .99265               1.0260                  11.1978E-04

      CRAT3    = C          1.0000                1.1393                  13.9260E-04
```



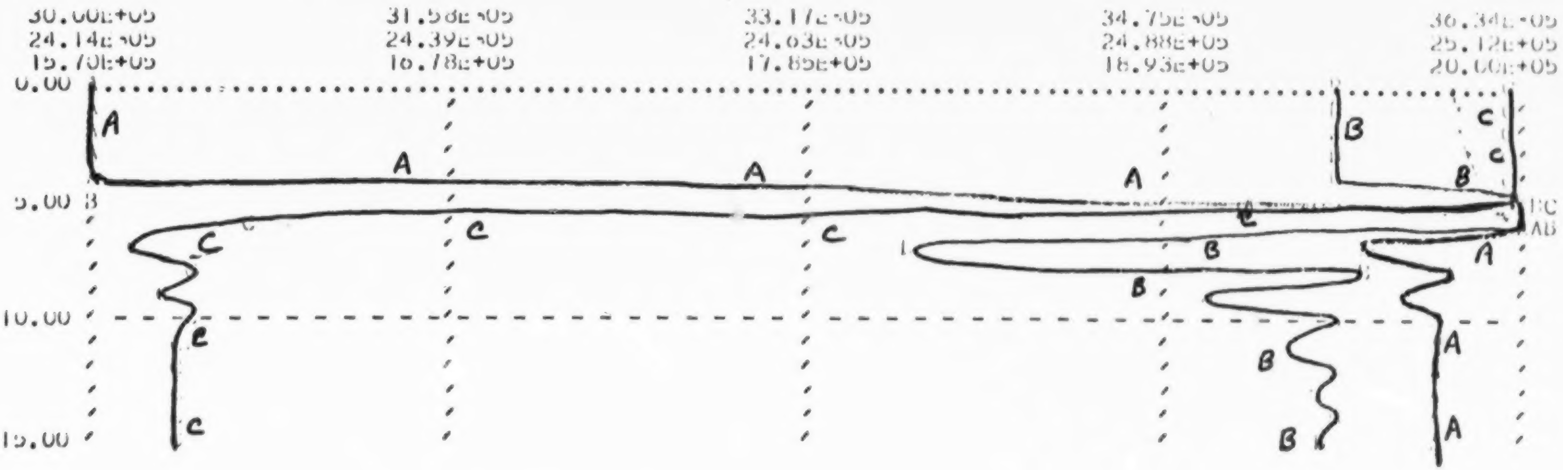
Generally closely similar behaviour to the parallel run with equal costs - the variation induced in group 2 is slightly stronger.

BEST COPY AVAILABLE

3. Resource distribution based on projected enrolments which are based on changes in average enrolments over time.

Costs : variable from group to group

```
UNI RESOURCE MODEL (ENROL SHOCK)

                        MIN               MAX                PLOT INCR
GR1      = A /      30.0000E+05       36.3372E+05          6337.2

GR2      = B |      24.1407E+05       25.1229E+05          982.21

GR3      = C /      15.7018E+05       20.0000E+05          4298.2
```



GROUP 1 resources settle to new value by T=8 (damped oscillation) - substantial adjustment by T=6

GROUP 2 is caught in the adjustment to the shock through system feedback but adjusts to a value near the original.

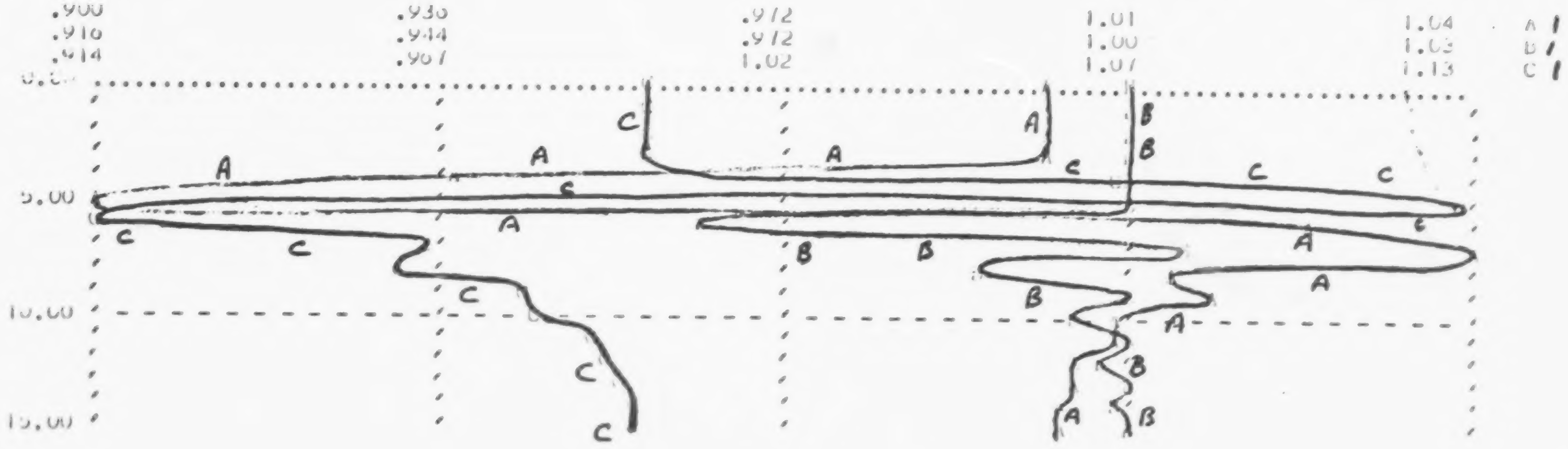
GROUP 3 undergoes similar variation to group 1 - behaviour is damped oscillation to a new equilibrium distribution.

The resource redistribution is considerably more effective than in the previous runs.

BEST COPY AVAILABLE

UNI RESOURCE MODEL (ENROL SHOCK)

```
                         MIN              MAX                   PLOT INCR
   CRAT1    = A |       .90000           1.0437        .        14.3729E-04

   CRAT2    = B |       .96563           1.0049                 11.1978E-04

   CRAT3    = C |       .91368           1.1250                 21.1316E-04
```



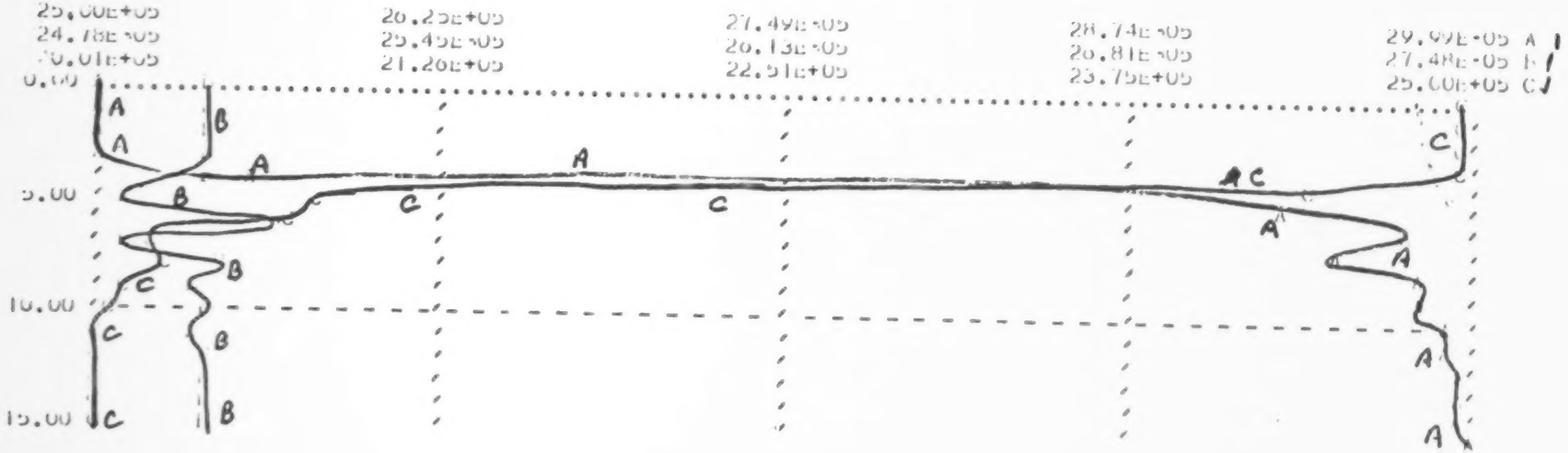
In contrast to the earlier runs the critical ratios stabilize around their original values indicating that group equity has been restored.

4. Resource distribution based on projected enrolment (2/3) modified by a weighting for current average enrolments (1/3)

"Normal" costs/student equal across groups.

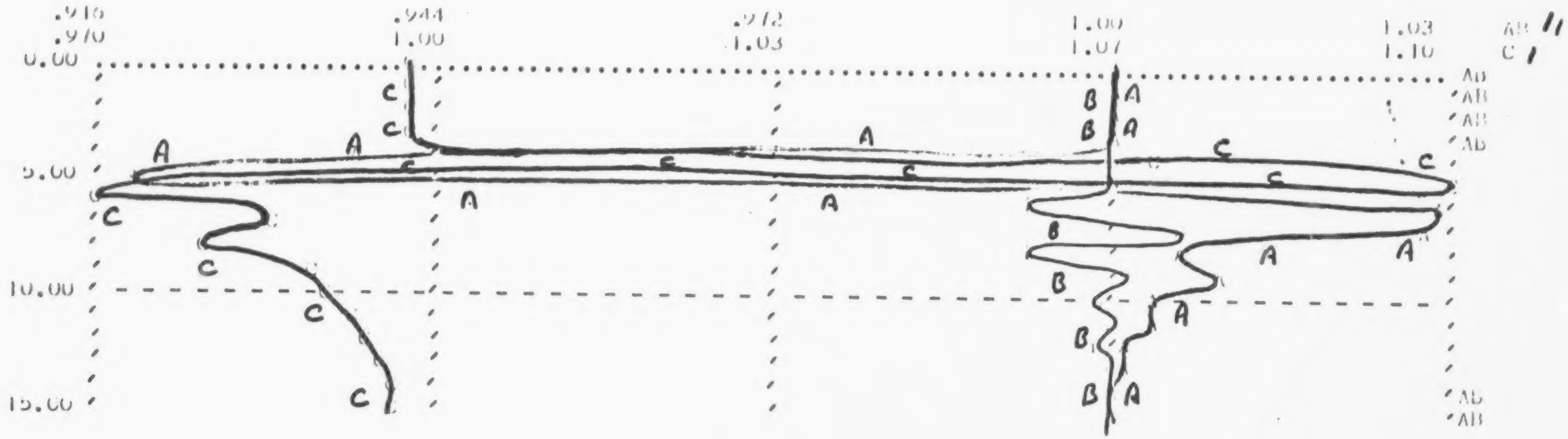
UNI RESOURCE MODEL (ENROL SHOCK)

		MIN	MAX	PLOT INCR
GR1	= A	25.0000E+05	29.9869E+05	4986.9
GR2	= B	24.8474E+05	25.1562E+05	2700.8
GR3	= C	20.0127E+05	25.0000E+05	4987.3



Comparing the output with run 3 it is observed that the behaviour is essentially similar but that the values taken by the variables are more contained. This is because the weighting for present average enrolments acts as a check adjusting the allocation policy towards current conditions while still allowing it to be based substantially on projected enrolments.

```
 UNI RESOURCE MODEL (ENROL SHOCK)



                         MIN             MAX                   PLOT INCR
     CRAT1    = A       .92000          1.0278          .      11.1978E-04

     CRAT2    = B       .99390          1.0062                 11.1978E-04

     CRAT3    = C       .96988          1.1000                 13.0115E-04
```



As with the group resources the critical ratios are more contained representing a somewhat improved performance.

* An extra run (not included) based allocation policy entirely on average enrolments. This run had similar behaviour modes but biased towards current conditions. The veracity of this policy basis is felt to be dubious as it could lead to a scramble for numbers to increase average enrolments and hence resources. However using average enrolments as a modifying influence on projected values as in run 3 has potential value in its containing effect described above.

BEST COPY AVAILABLE

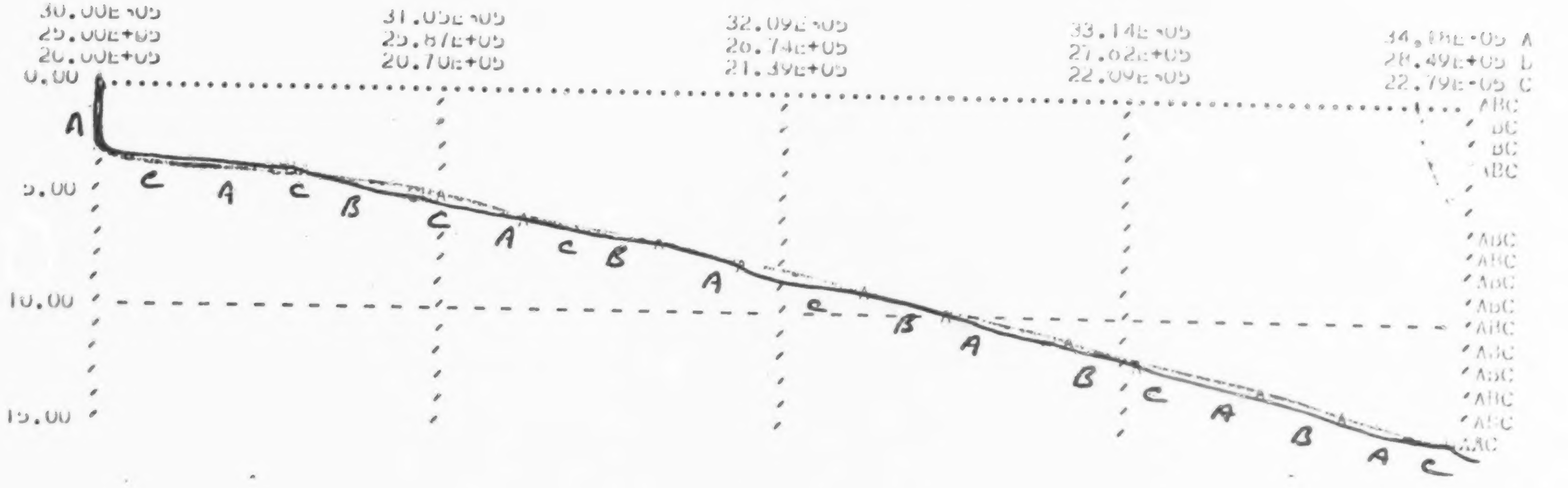
5. Basic allocation of resources is based on external goal for student numbers

Funding is based on the external numbers goal. (RAMP functions)

This run should be viewed as a test of model structure rather than a test of policy. The steadily degrading system is due to adherence to a given policy in the face of totally unsuitable circumstances. As a test of structure it is noted that imposition of extreme conditions should lead to extreme behaviour - and it does.

UNI RESOURCE MODEL (ENROL SHOCK)

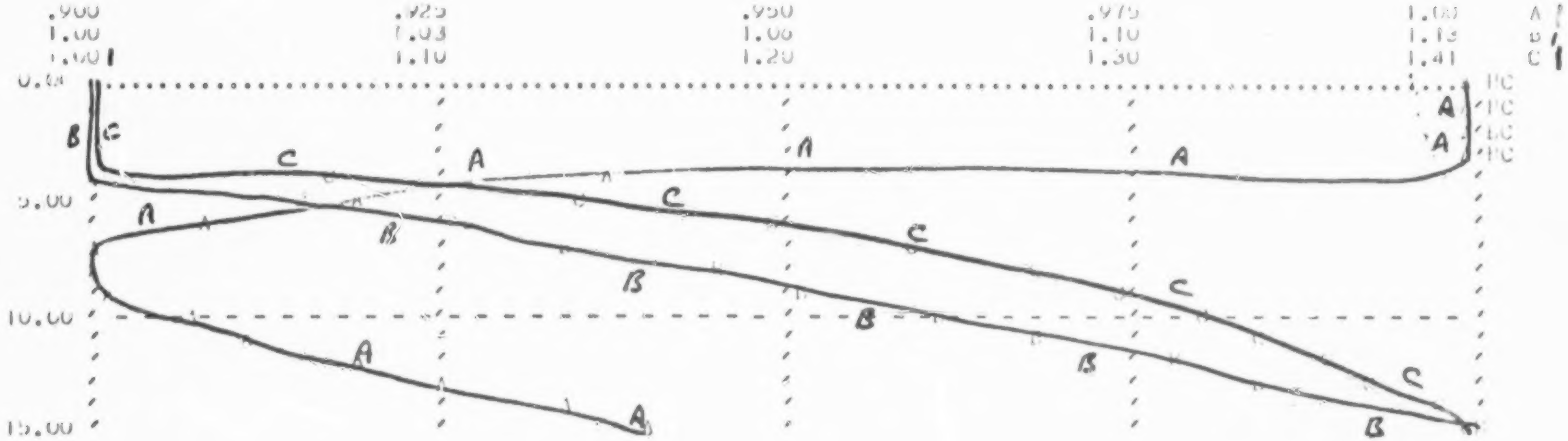
```
                    MIN              MAX              PLOT INCR
GR1    = A     30.0000E+05      34.1842E+05          4184.2

GR2    = B     25.0000E+05      28.4868E+05          3486.8

GR3    = C     20.0000E+05      22.7895E+05          2789.5
```



Here the group resources grow in accordance with the fixed plan to increase funds according to a ramp growth principle.

BEST COPY AVAILABLE

```
UNI RESOURCE MODEL (ENROL SHOCK)


                         MIN              MAX                  PLOT INCR

     CRAT1   = A     .89998           1.0000          .      10.0018E-04

     CRAT2   = B     1.0000           1.1270                 12.6988E-04

     CRAT3   = C     1.0000           1.4060                 40.6026E-04
```



The condition within the groups becomes increasingly inequitable. Group 1 suffers a surge in numbers so its resource/student ratio worsens from T=3 before gradually improving as it receives increasing resources according to the long term plan. Group 3 (that suffers a sharp drop in numbers) is substantially advantaged and the increasing resources it receives produces an ever increasingly favourable ratio. Group 2 which continues with stable numbers gradually benefits from the growth of resources over time. In this run feedback is effectively suppressed so that goal seeking adjustments cannot occur. While in practice such a policy would not be persisted with under the shock conditions imposed a useful point still emerges. This is the rigidity imposed by inflexible goals which on the surface seem to give comfort by prescribing a set future. It won't always be obvious whether changes in enrolment patterns represent fluctuations or new trends. If a new trend develops in a fixed goal based context it may be some years before it is recognized as a trend - in the meantime the beginning of problem system behaviour may well occur.

BEST COPY AVAILABLE

6. Each group has a different basis for allocation of resources.

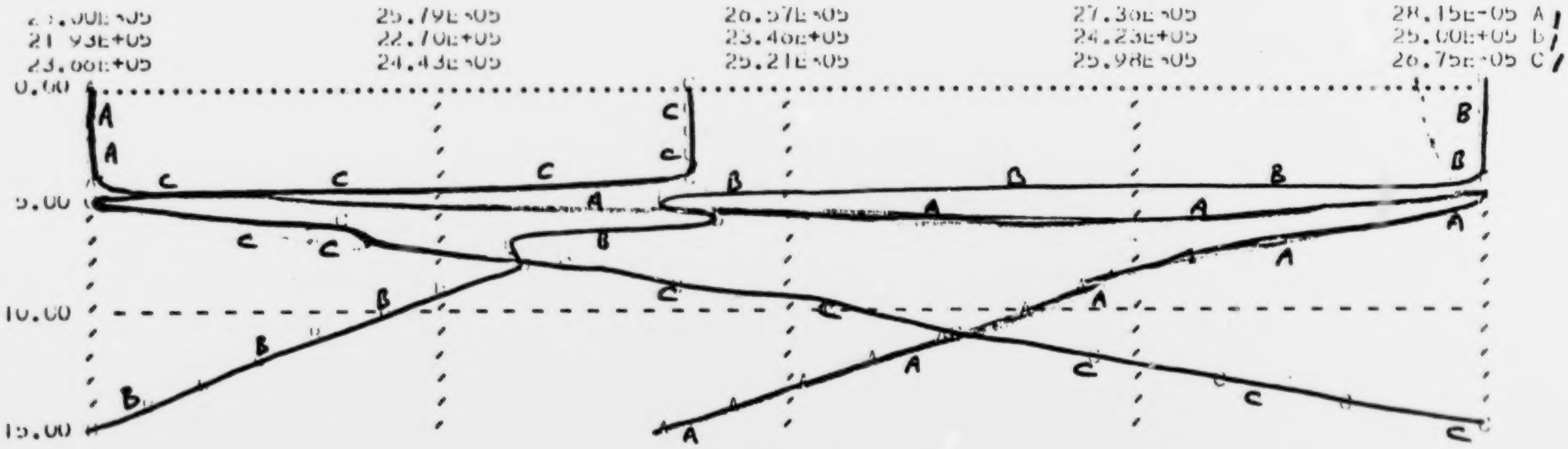
Group 1 : on the bais of projected enrolments

Group 2 : on the basis of average enrolments

Group 3 : on the basis of an externally determined growth goal (ramp)

Funding is on the basis of projected enrolments.

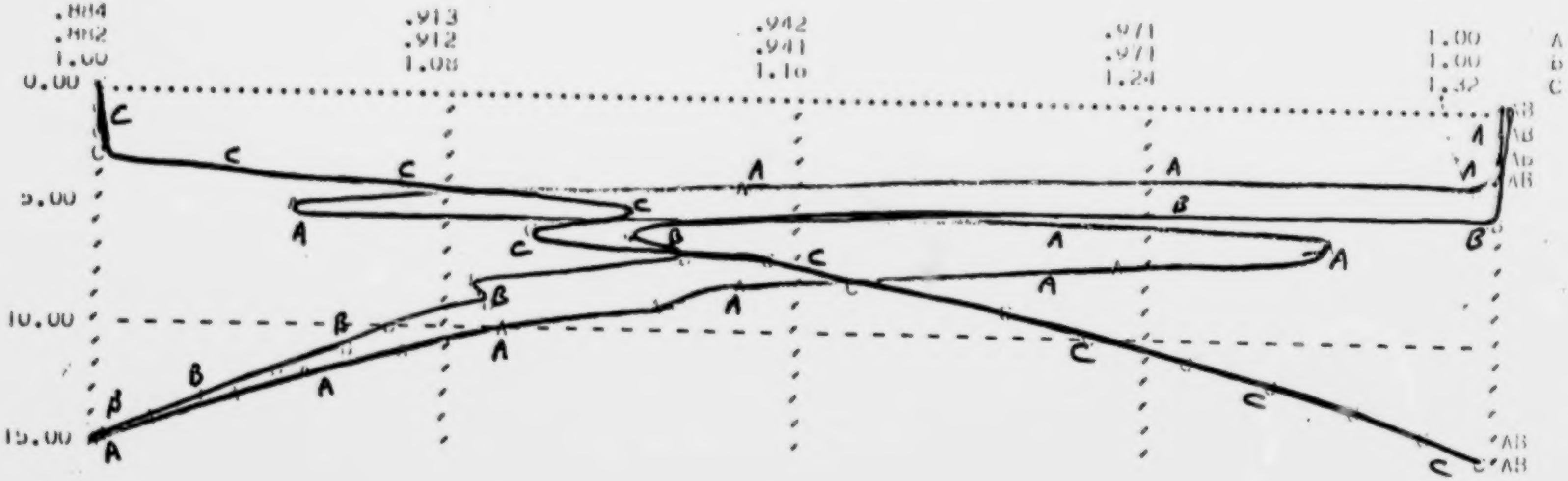
```
UNI RESOURCE MODEL (ENROL SHOCK)


                              MIN                  MAX                         PLOT INCR

       GR1       = A      25.0000E+05          28.1486E+05                    3148.6

       GR2       = B      21.9296E+05          25.0000E+05                    3070.4

       GR3       = C      23.6576E+05          26.7542E+05                    3096.5
```



In response to the initial shock resources are distributed towards group 1 and away from group 3. The alternative allocation policies then begin to exert influences. The external goal based policy in group 3 means that a regular increase in resources occurs so that group 3 resources show a steady increase after the initial response to the shock. Since these resources are committed they are removed from the total funds available leaving the remainder for distribution between groups 1 and 2. As group 3 resources steadily increase and numbers are stabilising groups 1 and 2 jostle for a steadily decreasing proportion of central funds. Hence group 1 resources regress from the level first achieved after the enrolment surge and group 2 resources are steadily eroded from the initial state. Groups 1 and 2 whose resource allocation is based on their on-going dynamic situation are disadvantaged in favour of group 3 which is protected by the policy geared to meeting a fixed external goal.

BEST COPY AVAILABLE

```
                         MIN              MAX                   PLOT INCR
   CRAT1    = A        .88350           1.0000                11.6496E-04

   CRAT2    = B        .88236           1.0000                11.7637E-04

   CRAT3    = C        1.0000           1.3210                32.1000E-04
```



The critical ratios reflect the relative positions of advantage/disadvantage of the groups. Group 3 shows a steadily improving situation after a brief fluctuation caused by the initial drop in numbers. Groups 1 and 2 have fluctuating ratios as they compete with each other for a steadily reducing proportion of central funds. An implication suggested by this run is the potential influence of a mechanism that has fixed goals in some areas and fluidity in others. The groups with fixed goals will generally benefit to the mutual discomfit of other sectors.

BEST COPY AVAILABLE

(A) EXPERIMENTS WITH ENROLMENT SHOCK AND AMENDED ENTRY CONDITIONS

(1) Uniform enrolment shock of +20% at T=3 in all groups.

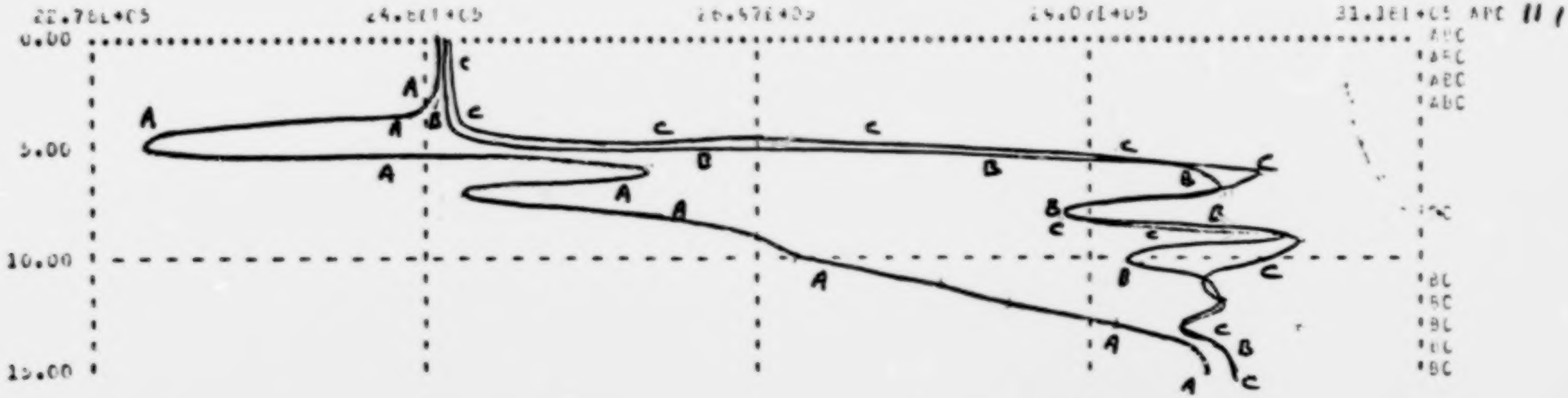
(2) Entry conditions (quotas) made more stringent in groups 1 (R11 = .95) and 2 (R21 = .85). (See Appendix B and C)
R12 22
Value retained at 0.75 in group 3.

These parameters determine how many of an increased number of applicants will be given places - see model equations.

(3) Resource allocation is on the basis of projected enrolments (weight 0.7) modified by current average enrolment in groups (weighting 0.3).

(4) Adjustment allocation is a proportional policy based on enrolments.

```
UNI RESOURCE MODEL

                    MIN                 MAX                 PLOT INCR
     GR1    = A |   23.1334E+05         24.4010E+05         6418.4
     GR2    = B |   25.0000E+05         30.4045E+05         6430.4
     GR3    = C  |  25.0000E+05         30.4269E+05         6418.4
```

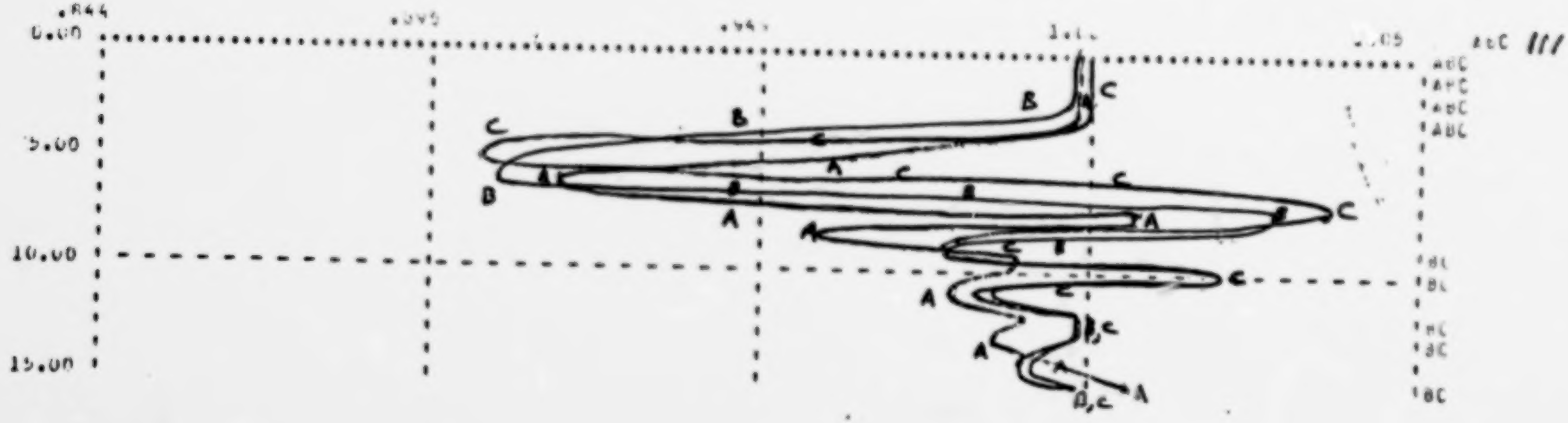


All groups move to equilibrium values through damped oscillations.

The stronger quota conditions in groups 1 and 2 influence the efficiency 2 variable (appendix B) and this will have implications for meeting student targets around T = 4 to 7.

BEST COPY AVAILABLE

```
                         MIN                 MAX                      PLOT INCR
   CRAT1    = A /      .91732              1.0167      .          21.08266-04
   CRAT2    = B \      .90369              1.0519                 21.08266-04
   CRAT3    = C/       .90505              1.0416                 21.08266-04
```



Magnitude of variation of the critical ratio is very similar as is their oscillatory behaviour. The "tight" quota policies are seen to be no more effective in controlling relative resource/student ratios than the more liberal policy of group 3. This indicates that under the distribution policy based on projected and average enrolments the group conditions are effectively controlled by the distribution policy and nothing is gained in this direction through the application of quotas. The quotas themselves may have inhibiting effects on other parts of the system.

BEST COPY AVAILABLE

(B) EXPERIMENTS WITH ENROLMENT SHOCK AND AMENDED ENTRY CONDITIONS

(1) Uniform enrolment shock of +20% at T=3 in all groups.

(2) Entry conditions (quotas) made more stringent in groups 1 (R11 = 0.95) and 2 (R21 = 0.85). (Appendix B and C)
Value retained at 0.75 in group 3. R12 R22

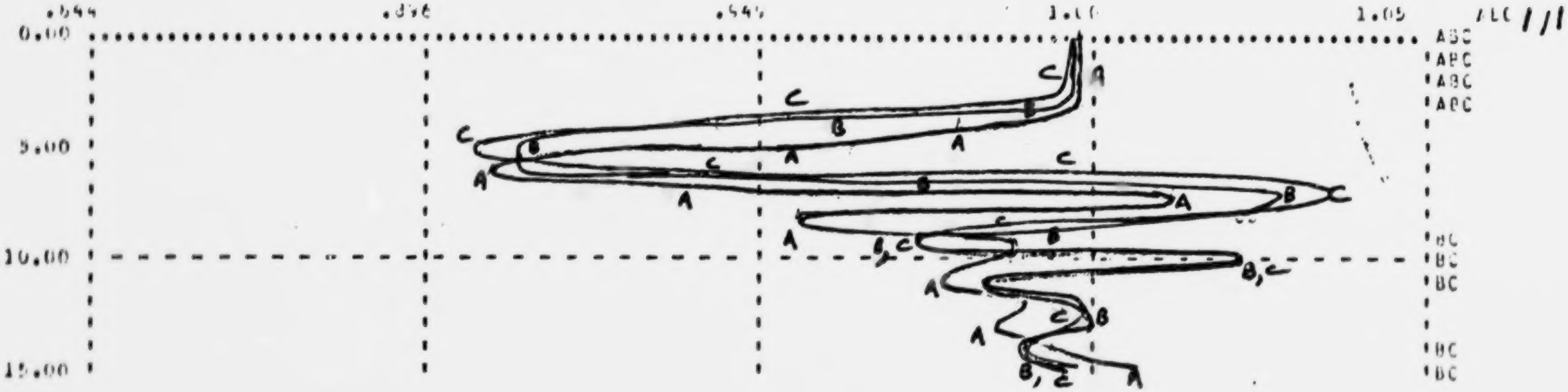
These parameters determine how many of an increased number of applicants will be given places - see model equations.

(3) Resource allocation is on the basis of projected enrolments (weight 0.7) modified by current average enrolments in groups (weighting 0.3).

(4) Adjustment allocation is based on group discrepancies.

UNI RESOURCE MODEL

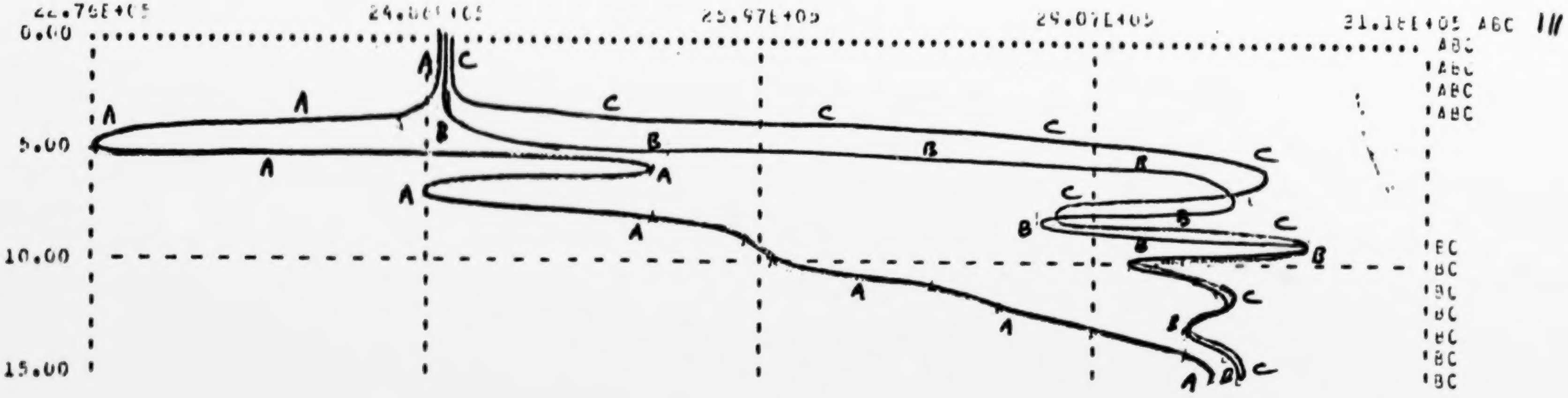
		MIN	MAX	PLOT INCR
CRAT1	= A	.90731	1.0145	21.0826E-04
CRAT2	= B	.91200	1.0214	21.0826E-04
CRAT3	= C	.90536	1.0413	21.0826E-04



The behaviour and amount of variation in the critical ratios is very close to that achieved using the enrolment adjustment policy.

UNI RESOURCE MODEL

```
                 MIN              MAX              PLOT INCR
GR1    = A |     22.7594E+05      29.8989E+05      8418.4
GR2    = B |     25.0000E+05      30.4569E+05      8418.4
GP3    = C |     25.0000E+05      30.4727E+05      8418.4
```



Comparison with the corresponding graphs for the parallel run with enrolment based adjustment indicates an exactly similar set of behaviour modes. Examination of the tabular output indicates variations in the values of the group resources by small but measurable amounts between the runs. An influence is that the adjustment policy, particularly when a proportional policy, will not achieve major changes in resource distribution between groups. However when 1% represents many thousands of dollars the difference between an enrolment based adjustment and a discrepancy based adjustment may still be worth consideration. Other issues to emerge include the nature of adjustments. For example instead of a proportional discrepancy polidy an alternative would be an adjustment policy based on the notion of criticality. Thus groups deemed to have "critical" discrepancies might receive all available adjustment resources which would have a stronger effect than a proportional policy.

BEST COPY AVAILABLE

(C) EXPERIMENT: GOAL BASED FUNDING AND GOAL/PROJECTED ENROL BASED DISTRIBUTION

(1) SYSTEM receives applicant shock in all groups (=20%) at T=3

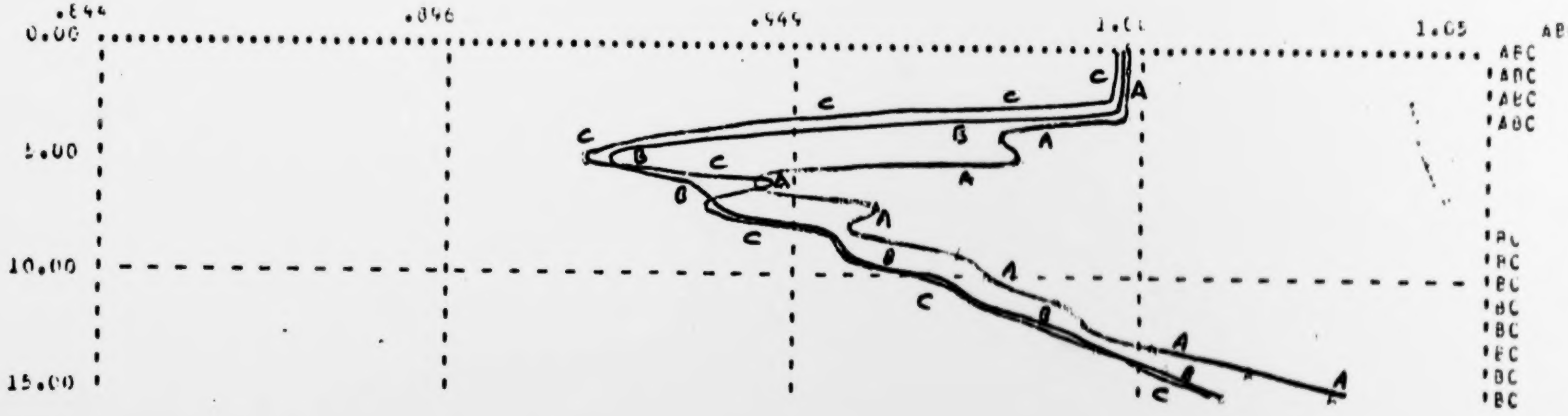
(2) Differential quotas apply as in experiments A and B.

(3) Funding is on a planned long-term basis - ramp function 2% per year flat.

(4) Resource distribution policy is matched to the funding - i.e. external goal determined according to a planned ramp increase in enrolments. However this policy is modified by a weighting that takes account of student demand which may deviate from the externally set goal. The weighting here is 0.3 for the goal and 0.7 for demand. (Another run with proportions reversed exhibited similar behaviour).

(5) Adjustment policy is on the basis of enrolments.

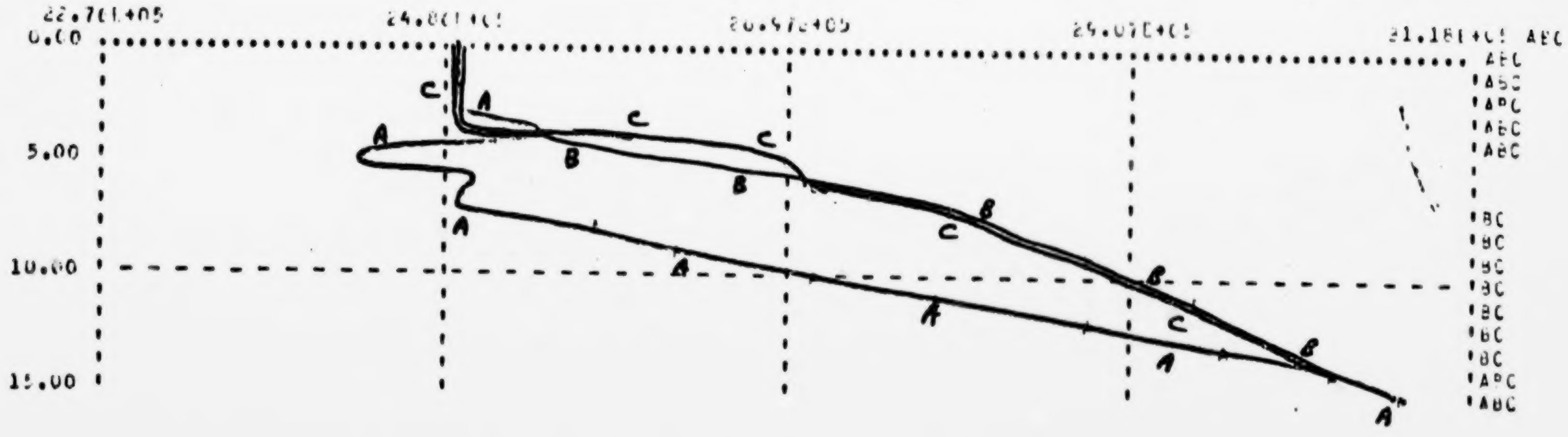
```
65/03/30.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                        PAGE  11
  UNI RESOURCE MODEL


                            MIN                   MAX                        PLOT INCR
        CRAT1    = A        .94463                1.0331                     21.0826E-04

        CRAT2    = B        .92253                1.0146                     21.0826E-04

        CRAT3    = C        .91823                1.0146                     21.0826E-04
```



The initial shock to enrolments is above the planned goal and produces discrepancies in all groups - group 1 is protected to a certain extent by tighter quota conditions. As the goal based funding increases more students enter groups 1 and 2 until all 3 groups have an intake 20% above their initial levels. Critical ratios become steadily more favourable during this time as resources grow faster than students. The modification for student demand means that students and funding are more closely matched than if the policy were externally goal based alone. Near the end of the run with student numbers at their maximum the increasing funds produce conditions in all groups that are more favourable than starting conditions. At this time funds remain unspent and so reduce the amount received in succeeding years. The additional rigidity in the system is reflected in the behaviour of Efficiency 2 (appendix B) which continues on a linear path rather than flexibly adjusting to a value near 1. This run is typical of a system where the attempt to control from outside leads to rigid and persistent behaviour. Policy intervention would be necessary before the completion of the run.

BEST COPY AVAILABLE

```
                         MIN                    MAX                    PLOT INCR
GR1      = A        24.3984E+05           30.8158E+05              8418.4

GR2      = B        25.0000E+05           30.8145E+05              8416.4

GR3      = C        25.0000E+05           30.8145E+05              8418.4
```



After effect of initial enrolment increase the external goal based funding policy provides steadily increasing resources disfused to all groups.

(D) EXPONENTIAL GROWTH IN ENROLMENTS

GROUP 1 : r1 = 2% p.a.

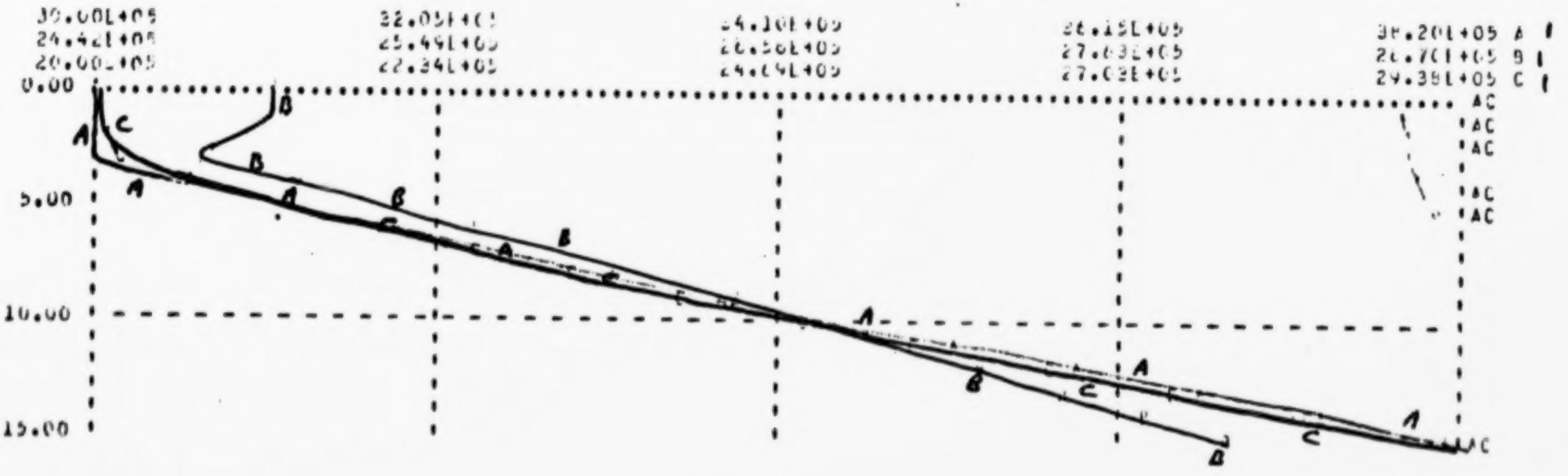
GROUP 2 : r2 = 0% p.a. (NO CHANGE)

GROUP 3 : r3 - 4% p.a.

DISTRIBUTION POLICY : HISTORICAL DISTRIBUTION MODIFIED FOR AVERAGE ENROLMENTS

UNI RESOURCE MODEL (ENROL EXPON GRWTH)

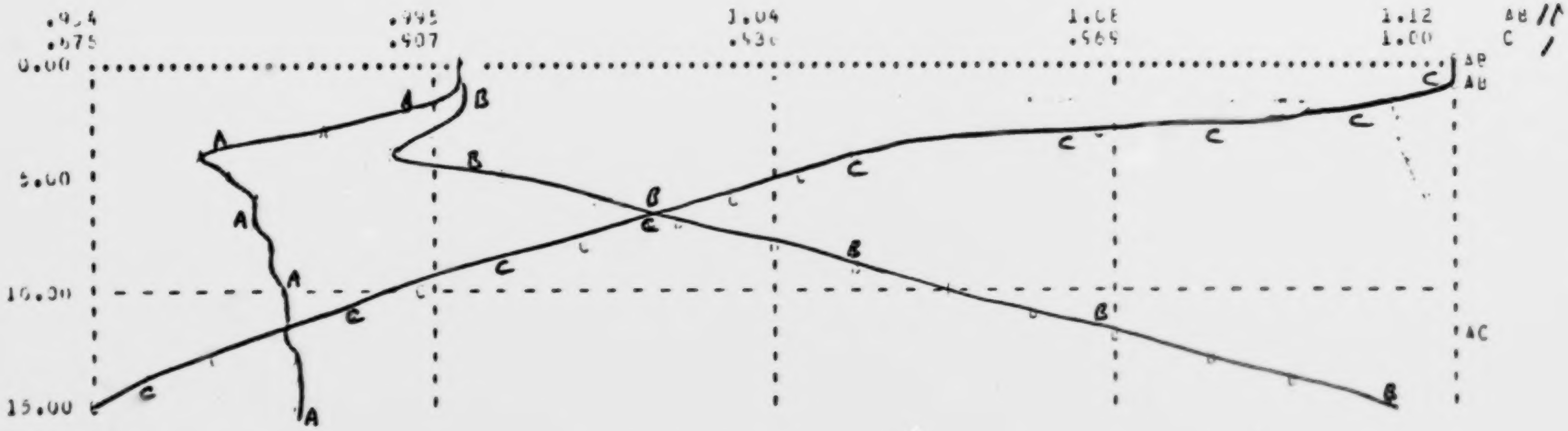
```
                      MIN                 MAX                 PLOT INCR
  GR1      = A |    30.0000E+05        38.2000E+05           8200.0

  GR2      = B |    24.7890E+05        28.0125E+05           4276.2

  GR3      = C )    20.0000E+05        29.3746E+05           9374.6
```



Steady growth in resources as steadily increasing enrolments stimulate increased resources. Group 2 benefits from the historical component of the distribution policy that allots a certain proportion of increasing funds although the enrolment is stable.

BEST COPY AVAILABLE

```
 UNI RESOURCE MODEL (ENROL EXPEN GRWTH)


                           MIN                 MAX                       PLOT INCR

      CRAT1     = A |      .95890              1.0000                    16.3867E-04

      CRAT2     = B |      .99156              1.1101                    16.3867E-04

      CRAT3     = C /      .87553              1.0000                    12.4367E-04
```



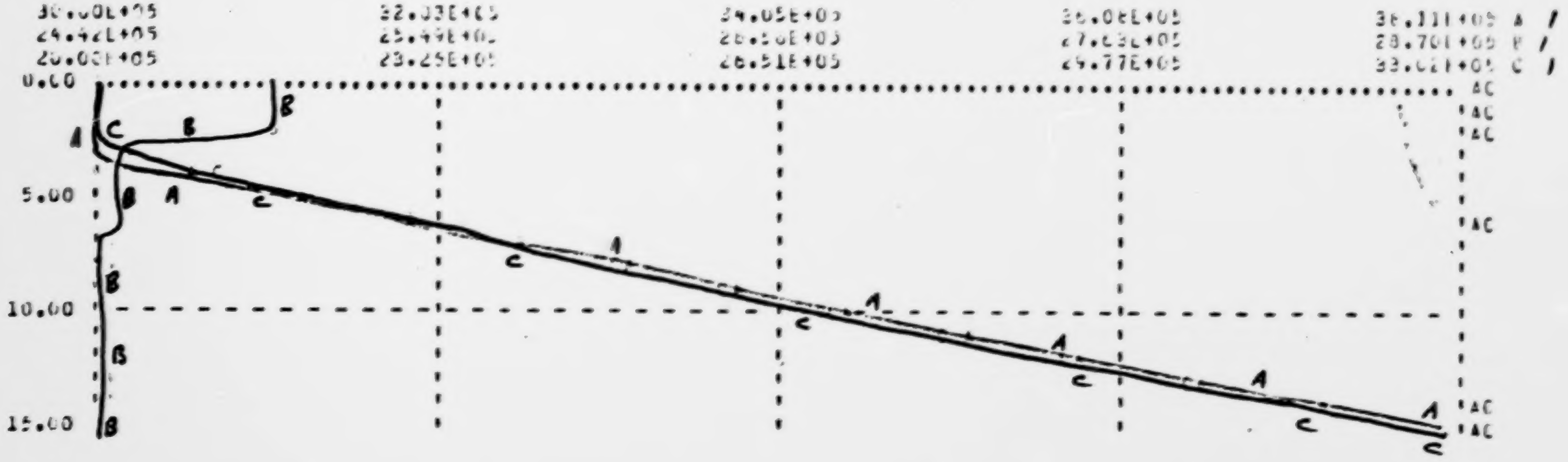
Critical ratios (discrepancies) in groups 1 and 3 gradually deteriorate. In group 1 the lower rate of student increase means that the deterioration is arrested due to the overall increase of funds received as a result of the strong growth in group 3. The historical component of the distribution policy ensures some of these resources come to group 1 and these partly compensate for the increased student numbers. Group 2 is considerably advantaged through the resource distribution policy. Conditions in group 3 deteriorate in an almost linear way since the location of the strongest growth in the group is not matched by an increase in resources some of which are directed by the distribution policy to groups 1 and 2.

BEST COPY AVAILABLE

(E) EXPONENTIAL GROWTH IN ENROLMENTS

DISTRIBUTION POLICY BASED ON PROJECTED ENROLMENTS

```
05/04/10.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                    PAGE   2
UNI RESOURCE MODEL (ENROL EXPCN GRWTH)


                              MIN                    MAX                         PLOT INCR

        GR1       = A          30.0000E+05            38.1068E+05                 8106.8

        GR2       = B          24.4649E+05            25.0000E+05                 4276.2

        GR3       = C          20.0000E+05            33.0246E+05                 13025.
```

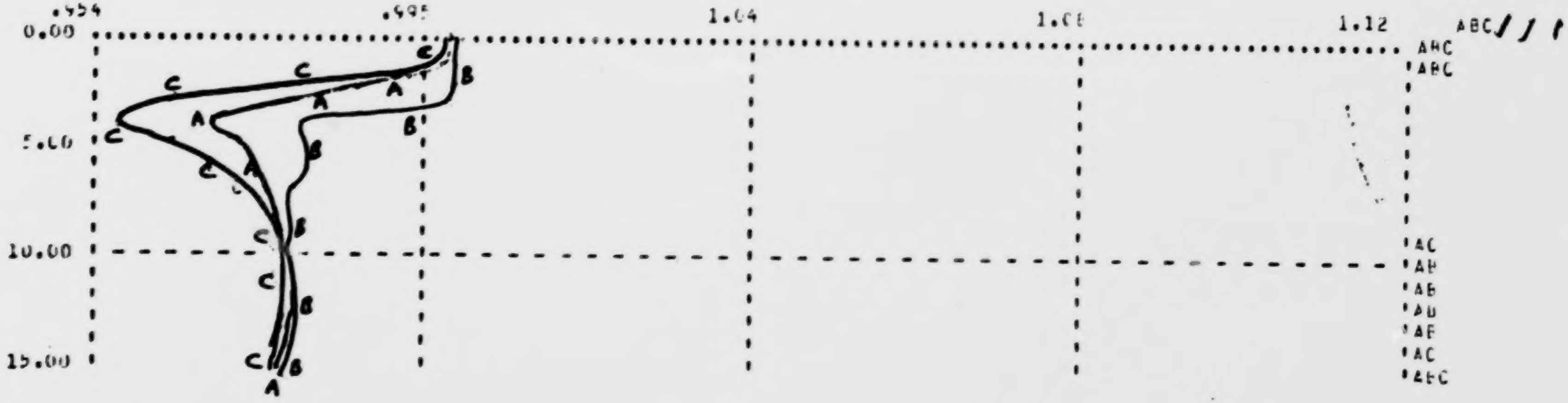


The steady growth in enrolments in groups 1 and 3 is reflected in the increased resources distributed to these groups.

Group 2 settles to a dynamic equilibrium in which resources are slightly lower than the original value - feedback induced redistrubiton.

BEST COPY AVAILABLE

```
                           MIN                 MAX                      PLOT INCR
     CRAT1   = A |        .96952              1.0000                   10.3867E-04

     CRAT2   = B |        .97082              1.0000                   10.3867E-04

     CRAT3   = C |        .95707              1.0000                   10.3867E-04
```



All critical ratios (discrepancies) exhibit similar behaviour and reach similar equilibrium values. The system settles to a dynamic equilibrium in which each group is slightly disadvantaged with respect to starting conditions on account of growth in student numbers remaining slightly adhead of growth in funding. The capacity of a dynamic history policy (with allocation principles based on projections from movements in average enrolments) to achieve satisfactory redistribution of resources is reinforced. With exponential growth the adjustment of critical ratios is essentially similar to that achieved under an enrolment shock.

BEST COPY AVAILABLE

(F) ENROLMENT DOUBLE SHOCK

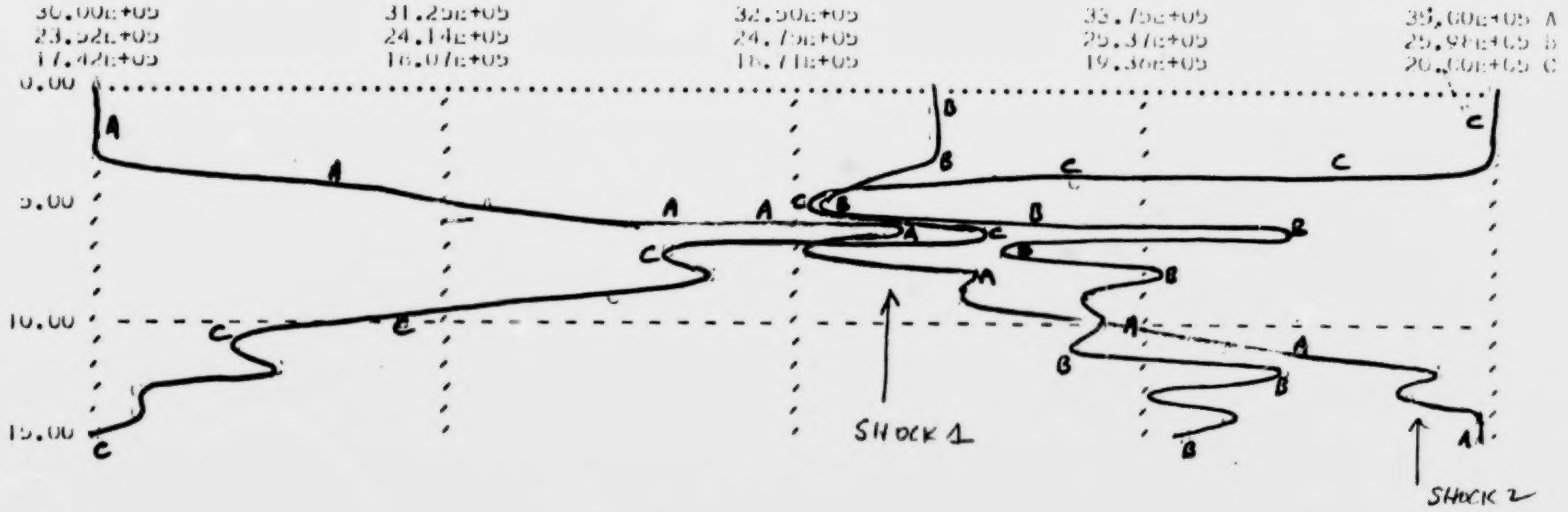
GROUP 1 : =20% at T=3 then +10% (additional) from T=9

GROUP 2 : UNIFORM RATE (no change)

GROUP 3 : -20% at T=3 then -10% (additional) from T=9

HISTORY POLICY WEIGHTED BY AVERAGE ENROLMENTS

```
85/04/16.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                    PAGE   20
GRI RESOURCE MODEL (CONTROL DOUBLE SHOCK AT T=3 & T=9

                          MIN                    MAX                         PLOT INCR

     GR1      = A      30.0000E+05           34.9957E+05                   4995.7

     GR2      = B      24.8162E+05           25.6492E+05                   2464.5

     GR3      = C      17.4216E+05           20.0000E+05                   2578.4
```

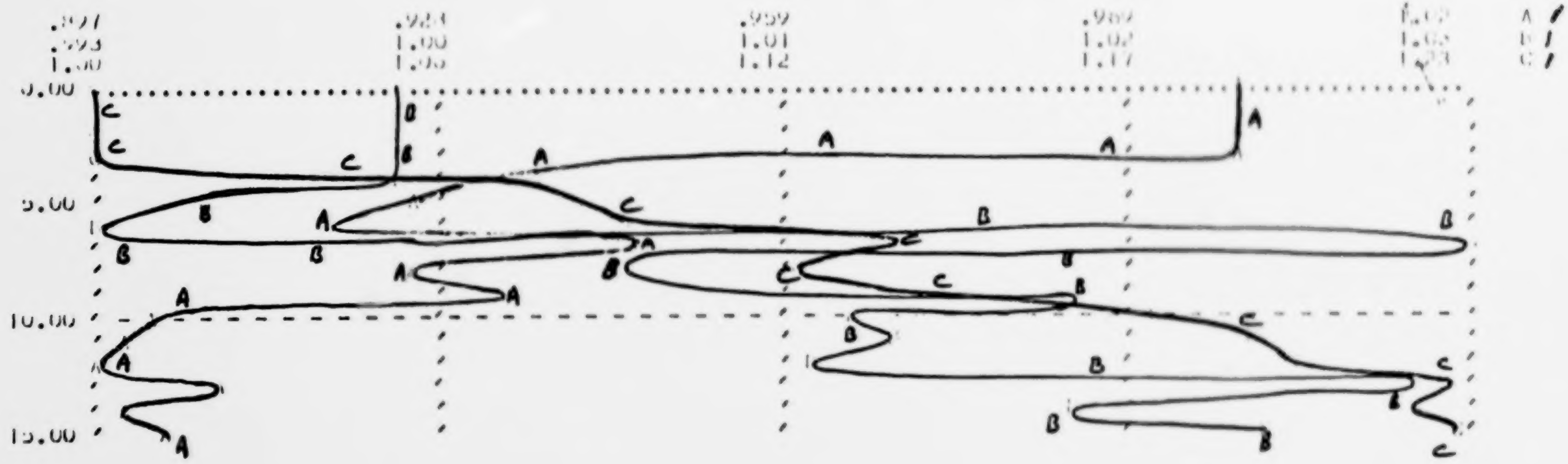


GROUPS 1 and 3 exhibit distinct resource shifts in response to shocks

GROUP 2 experiences some induced variation due to feedback and stabilizes at at more favourable position.

BEST COPY AVAILABLE

```
85/04/10.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                          PAGE   23
 UNI RESOURCE MODEL (CONTROL DOUBLE SHOCK AT T=3 & T=

                          MIN                   MAX                          PLOT INCR

      CRAT1    = A /      .89733               1.0000                       12.2675E-04

      CRAT2    = B /      .99265               1.0260                       33.3216E-05

      CRAT3    = C /      1.0000               1.2332                       23.3191E-04
```



CRITICAL RATIOS for groups 1 and 3 move to new positions of dynamic equilibrium in response to shocks. Group 1 conditions represent relative disadvantage and group 3 conditions substantial relative advantage. Group 2 experiences induced oscillations which stabilize to a better final state with respect to resource ratios per student.

BEST COPY AVAILABLE

(G) ENROLMENT DOUBLE SHOCK

GROUP 1 : +20% at T=3 then +10% (additional) from T=9

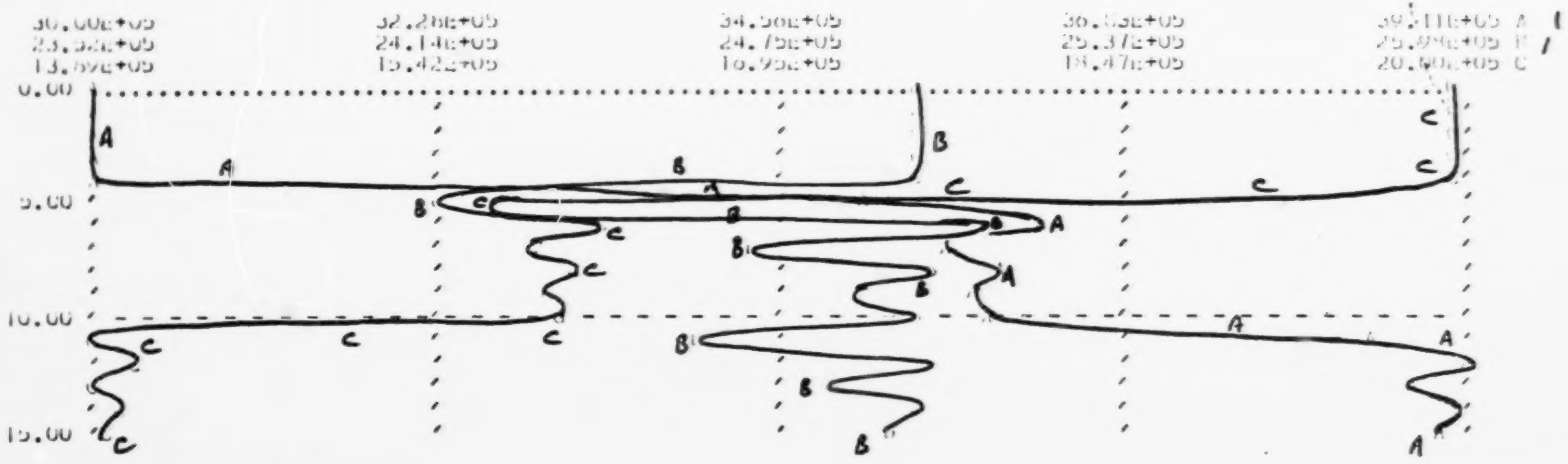
GROUP 2 : UNIFORM RATE

GROUP 3 : -20% at T=3 then -10% (additional) from T=9

ALLOCATION POLICY BASED ON PROJECTED ENROLMENTS

ENROLMENT DOUBLE SHOCK (ALLOCATION BASED ON PROJECTED ENROLMENTS) (DEMAND)

```
75/04/10.          SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                PAGE  26

UNI RESOURCE MODEL (ENROL DOUBLE SHOCK AT T=3 & T=9

                            MIN               MAX                   PLOT INCR

      GR1      = A /       30.0000E+05       39.1124E+05            9112.4

      GR2      = B /       24.1407E+05       25.1229E+05            2464.5

      GR3      = C         13.8913E+05       20.0000E+05            6108.7
```

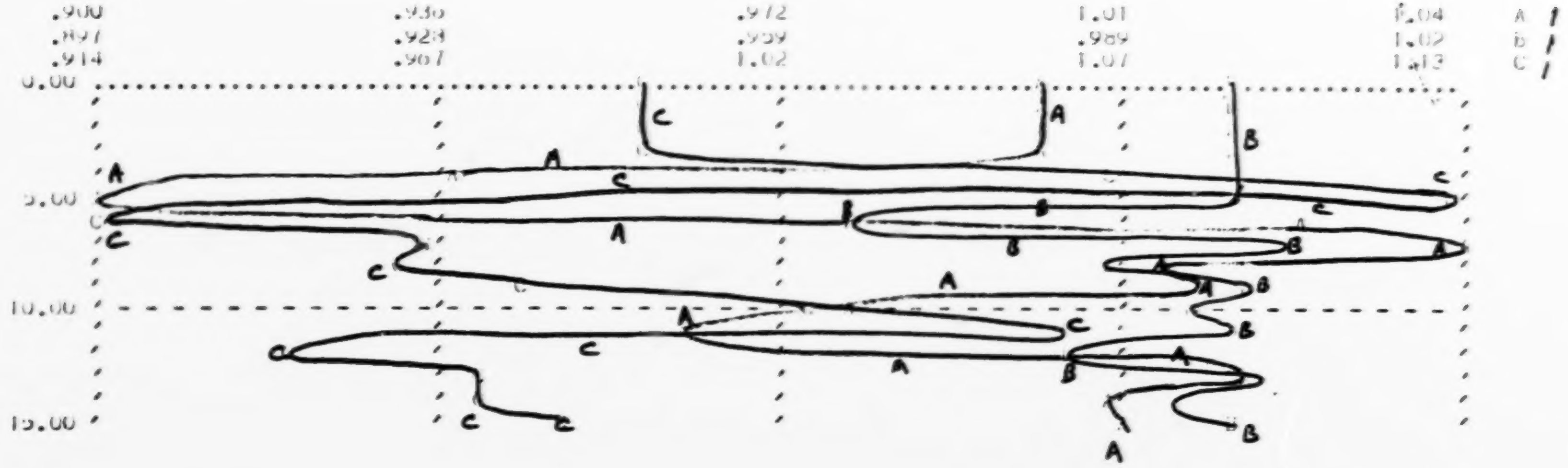


Groups 1 and 3 respond to double shock with movements to successive positions of dynamic equilibriu. Resource distribution more widely spread than for historically based distribution. Group 2 experiences damped induced oscillations and resources settle to a dynamic equilibrium close to original value.

BEST COPY AVAILABLE

UNI RESOURCE MODEL (ENROL DOUBLE SHOCK AT T=3 & T=9

```
                     MIN              MAX                    PLOT INCR

CRAT1    = A /     .90000           1.0437                 14.3729E-04

CRAT2    = B /     .96563           1.0049                 12.2675E-04

CRAT3    = C /     .91368           1.1250                 21.1316E-04
```



Induced oscillations in Critical Ratio (DISCREPANCY) variables are damped to final values near to initial equilibrium values i.e. the system has adjusted resources so that the groups return to positions of comparable resource/student ratio. This contrasts with historically based distribution policy.

BEST COPY AVAILABLE

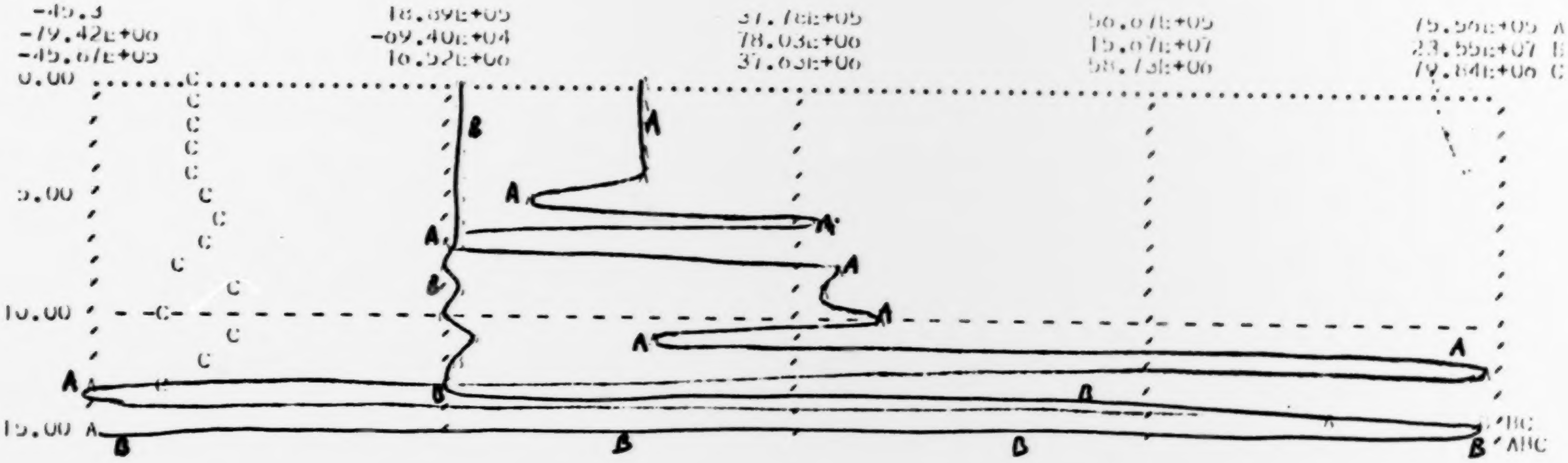
(H) EAT = 1 : ADJUSTING TOO QUICKLY TO ENROLMENT CHANGE

Enrolment averaging time = 1 year : Model is unstable for this value of EAT.

Parameter Sensitivity

Note: Test with EAT = 5 resulted in extremely stable behaviour as might have been expected from the satisfactory results obtained from EAT = 3.

```
85/04/03.           SYSTEM DYNAMICS RESEARCH GROUP, UNIVERSITY OF BRADFORD                    PAGE   12
 UNI RESOURCE MODEL

                         MIN                    MAX                       PLOT INCR

        GR1     = A      -45.307                75.5648E+05               75565.

        GR2     = B      -79.4151E+06           23.5469E+07               31.4884E+05

        GR3     = C      -45.8651E+05           79.8376E+06               84.4241E+04
```

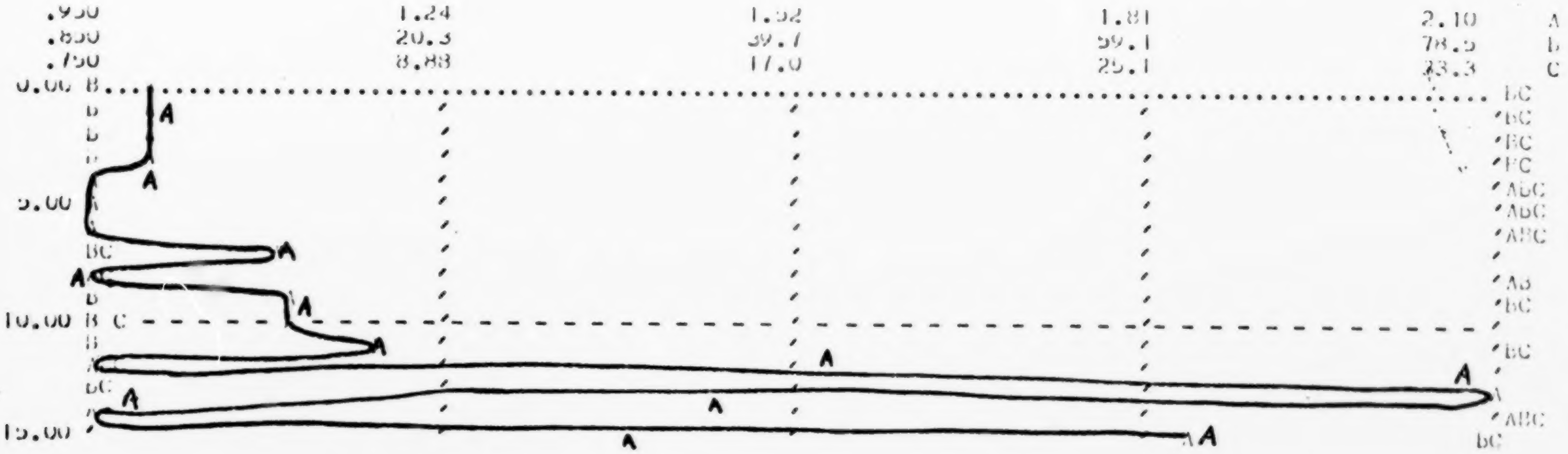


EXPLOSIVE OSCILLATIONS

Model instability - too rapid attempt to adjust to changing conditions

BEST COPY AVAILABLE

```
UNI RESOURCE MODEL


                              MIN                 MAX                     PLOT INCR

     CRAT1     = A          .95000              2.0990                  11.4902E-03

     CRAT2     = B          .85000              78.490                  .77640

     CRAT3     = C          .75000              33.266                  .32516
```



EAT = 1 EXPLOSIVE OSCILLATIONS

BEST COPY AVAILABLE

SUMMARY

1. Parameter Sensitivity

A series of tests have found the model behaviour to be insensitive to variations in the costs/WSU within the groups and to changes in the magnitude of enrolment intakes.

The only parameter which proved to be sensitive was the enrolment averaging time (EAT). This is an important parameter, representing the time over which average enrolments are adjusted in terms of changing intake rates. When EAT was assigned the value 1 the model went into uncontrolled oscillation and the system became unstable when disturbed by enrolment shocks. However for values of EAT $\geqslant$ 3 the model behaviour was stable and controllable. This implies that for enrolment averaging times of 3 years the model provides stable and consistent output across a variety of policy alternatives. The unstable value of EAT=1 corresponds to attempts to adjust average enrolments almost instantaneously to new intakes and indicates that such a practice will lead to instability. The stable behaviour that characterizes the model when the enrolment averaging time is of the order of a triennium suggests that 3 years is a reasonable choice for a time period over which to adjust enrolment rates for planning purposes.

2. Policy Analysis

The basic allocation policies considered represented various weightings of mechanisms based on historical distributions, on projected enrolments calculated from perceived movements in average enrolments, on current values of average enrolments, and on externally set enrolment growth goals.

(1) Policies based upon fixed (static) historical distributions were unsatisfactory even when weighted for shifts in enrolments from traditional patterns. Changes induced in student/resource ratios persist and in some instances worsen. The weighting for enrolment change serves only to alleviate a situation that would otherwise be worse. Such a policy may be likened to a rubber band fixed at one end (historical position) and stretched by varying amounts (new enrolment patterns). A weighting policy locates resource distribution formulae at some point along the stretched band. Consequently the allocation is always inadequate to meet the needs appropriate to the stretched end. As the band stretches with time the consistent choice of an intermediate position means that the relative position becomes increasingly disadvantaged since the differences between needs and allocations are accumulated (integrated) over time. One can take the analogy of the rubber band further by saying that too much stretching will inevitably lead to the band snapping. The university resource allocation system would also collapse if overstretched.

(2) Policies based on enrolment projections calculated from movements in average enrolments stabilized over an averaging time have the effect of releasing the fixed end of the rubber band. Such policies are based on a concept of dynamic history and it is suggested by the model that we should move to adopt such a policy. Model output is stable for such policies and resource distribution is achieved smoothly and in such a way that student/resource ratios return to equilibrium values through the operation of internal adjustment (feedback) processes.

(3) Policies based solely on externally set targets suffer from a rigidity that prevents information from system feedback from assisting to adjust allocations in line with deviations from the target. In reality adjustments would be made post-hoc when it is realised that targets in particular areas are not being met. Model runs suggest that a useful procedure is to use current values of average enrolments as a weighting factor to amend discrepancies between goals and actual enrolments. It can be noted that when a group is such that its goal (quota) is always filled then a goal policy is numerically equivalent to the dynamic history policy. It is when goals are not met, and in particular, when their fulfilment is subject to variation from year to year that the rigidity of a goal based policy is most harmful.

(4) The stability of the model to cost shock indicates that fundamental behaviour generated by particular allocation policies

is not upset by movements in the "normal" cost/WSU that might occur through e.g. changes in teaching technology. This does not mean that a redistribution of resources will not occur (it will) but it indicates that the occurrence of cost changes is irrelevant as far as the resilience of an allocation policy is concerned. Similarly the insensitivity of model behaviour to the relative costs within different groups indicates that the allocation policies are general and their appropriateness is not a function of specific group cost measures.

Adjustment Allocations

The concept of an adjustment to group funding made after the basic allocation is an interesting option. While such an initiative will be mandatory when funds received are less than those planned for, or when an additional allocation is received, the possibility of including such a process as an essential part of the allocation mechanism presents itself. For example by withholding a small percentage of total funds from the basic allocation. There then arises the possibility of alternative criteria as for example the model use of group enrolments and group disadvantage as alternative bases to define adjustments to basic allocations.

While a proportional policy is in some sense a natural and obvious mechanism, the model sheds insight on why proportional policies are relatively ineffective in achieving substantial redistributions. This is evident from the numerical data of the model output but is clarified by the feedback diagrams in Figure 3 and 4. In adopting any proportional policy, two opposing feedback loops are active. For example if it is proposed to distribute additional funds in proportion to average enrolments, the loop generating the increase in enrolments working in favour of group 1 say, is undermined by the loop that adds the same increase to the total enrolment. This total enrolment forms the denominator in the calculation of the proportional adjustment. A similar circumstance prevails if the SIZE of group discrepancy is used as a basis for the adjustment. Hence while some redistribution in the intended direction will be achieved it will not be as effective as perhaps hoped for.

A similar argument holds when a reduction in total resources means that groups are required to share cuts to their basic allocations. Other possibilities exist that might be considered as alternatives to proportional policies. One example would be to replace a proportional discrepancy based policy by one based on a notion of criticality. That is a condition that might be agreed under which the situation of a group(s) would be regarded as critical. All adjustment resources might then be diverted to that (those) groups. This policy has the effect of deactivating one of the opposing feedback loops so enabling a more decisive change in resource relativities to occur.

APPENDIX A

INTERVIEW SCHEDULES AND HEAD OF DEPARTMENT QUESTIONNAIRE

Vice-Chancellor & Deputy-Vice-Chancellor (Interview Schedule)

1. (a) Can you give a brief description of AR & PC and how it operates?

   (b) What is the relationship between AR & PC and the Senate Finance Committee?

   (c) How quickly (hours or days) can AR & PC react to a resource allocation decision?

2. Can you describe the respective roles of the Academic Board, AR & PC, Research Committee, Senate, other?

3. (a) What changes in work definition and time load have occurred for you as a result of the restructuring?

   (b) What is the perceived relationship between the DVC (F&F or Academic) and the PVC's?

   (c) What is the perceived relationship between the DVC (F&F or Academic) and the VC?

   (d) To what extent do you see the resource groups competing with eacn other?

   (e) To what extent do you place importance on the resource group's ability to acquire outside funds to gain flexibility in resource allocation?

4. (a) Are there major decisions for which the principal influences originaate outside the resource groups? Examples?

   (b) Where are typical sources of resource allocation processes? Examples?

   (c) Where are typical sinks? i.e. where does the ultimate action occur? (or get lost or peter out?) Examples?

   (d) A cycle exists when the consequences of a decision work through a system to eventually affect the system at the point where the initial decision was taken.

   Can you identify cycles within the university decision making structure? Examples?

   (e) Are there structures through which all resource allocation mechanisms are channelled?
   e.g. Is AR & PC such a structure?

5. Do you think there should be some services funded centrally?
   e.g. admin, computing, library, farm, trawler.

Why should they be funded centrally? If they are funded centrally who should control them?

6. What are the key indicators of a successfully operating university?

Interview Schedule - Pro-Vice-Chancellors

1. Can you give a brief description of AR & PC and how it operates?

2. What do you see as your own role as a VC/PVC? What changes in work defer and time load have occurred since restructuring.

3. What is the relationship between AR & PCand the Senate Finance Committee? Role of VC, Academic Board, Research Committee, Resource Groups?

4. How quickly (hours or days) can AR &PC react to a resource allocation decision?

Relationship of the PVC to his Group.

1. What is the Group Council Structure?

2. Can you comment on its mode of operation?

   a) Collegiate - cooperative
   b) Hierarchical with the PVC determining order of business, etc. for ratification.
   c) Explore the case history of a particular decision.
   d) Are there some decisions that don't have to be ratified by AR & PC or the VC's?
      i) If so, what are they?
      ii) If not, why not?

3. What is the perceived relationship between the PVC and his Deans?

4. What is the perceived relationship between the H.O.D.'s and the PVC?

5. Description of the Group resource allocation mechanism.

   i) Is it one of confrontation between departments where they have to justify their requests before the whole group; or
   ii) Does the PVC act in a clearinghouse role of collating and consolidating departmental requests and forward them to? (Some other person or group for a decision).

6. To what extent do you see the Resource groups competing with each other?

7. To what extent do you place importance on the group's ability to acquire outside funds to gain flexibility in resource allocation?

8. Do you think that there should be some services funded centrally? i.e. administration, computing, library, research, equipment other than computing, other facilities, i.e. farm, trawler, ...

   Why should they be funded centrally? and if they are funded centrally, who controls them?

9. What are the key indicators of a successfully operating resource group?

Interview Schedule - Head of Department

1. How do you perceive the Group Council Structure?

2. Can you comment on its mode of operation?

   (a) Collegiate - cooperative
   (b) Hierarchical with the PVC determining order of business etc for ratification

3. What is the perceived relationship between the HOD's and the PVC?

4. Description of the Group resource allocation mechanism

   (i) Is it one of confrontation between departments where they must justify and fight for requests before the whole group; or

   (ii) Does the PVC act in a clearinghouse role of collating and consolidating departmental requests for action at a higher level.

5. How would you compare the present arrangement with the situation before the creation of the resource groups.

   (a) Positive factors?
   (b) Negative factors?

6. Has the autonomy of departments been affected by the re-organization? How?

7. Have you any suggestions for improving the functioning of the present system?

8. What are the key indicators of a successfully operating department?

9. What are the key indicators of a successfully operating university?

10. Can the group council be bypassed by departments in any major decision area?

Heads of Departments (Information on restructuring of university) (Questionnaire)

1. How has the operation of your resource group and its Pro-Vice-Chancellor affected the work of your department and the relations between departments in your group?

   Positive factors!

   Negative factors!

   Other!

2. How has the creation of the resource groups contributed to the functioning of the University?

   Positive factors!

   Negative factors!

   Other!

3. What would be your preference for decision making structures in addition to or instead of the present arrangement?

4. What areas of decision making (if any) remain a matter of concern to your department?

5. Other.

** Please include the name of your resource group on any reply.

Interview Schedule - Deans

1. Would you like to comment on restructuring as it has affected the faculty?
2. What is the present relationship of Deans with Head of Departments?
3. How would you improve the decision making structures of the University? (In particular the relationships between faculties and resource groups)
4. Do you, as a Dean contribute to the Group's decision making in a way which goes beyond the immediate departments you are responsible for?
5. Have you other points you would like to raise?

Appendix B

Model Equations

Equation 1 (Group 1 resources) GR!

This equation defines the amount of resources ($yr) allocated to group 1. The figure output at T=N represents the resources for the next year T=N+1. Resources are allocated on a cost-weighted basis in terms of a COST/WSU that is regarded as the cost for a student in that particular group.

COST/WSU can vary fro group to group, to model the reality that costs of education vary across groups. The method of determining COST/WSU have not been addressed in the model.

The model traces implications of variations in these costs however defined.

Equation 2 (RALG1)

This equation defines the rate of resource allocation to group 1 according to the particular allocation policy being applied. Parameters H1, N1, P1, O1 are switching constants - in linking them with alternative policies only non-zero values are cited. All parameters not cited have zero values within the particular option.

H1=1:	policy based on historical allocation distribution
H1=1. N1=1:	policy based on historical principles modified by recent data on average enrolments.
P1=1:	policy based on dynamic demand variables - details provided in later discussion.
P1=1, O1=1:	policy based on dynamic demand variables with outside funds also available to group.

The above policies apply to the basic allocation procedure. The incorporation of adjustments to the allocation are detailed at a later stage and are switched in through the switching parameters defined with the Adjustment (ADJ1) formulation.

Equation 3 (HIST1)

This equation incorporates both the purely historical and the modified historical allocation policy. When N1=0 the purely historical policy continues to allot resources in proportion to the original group distributions that applied at the initialization of the model. When N1>0 a weighting is added in terms of shifts in student load (average enrolment) that have occurred since the initial state of the model. The modification is achieved by adding a cost weighted enrolment factor. The parameter N1 can be given any positive value to represent the magnitude of the modification. In the limit as N1-0 the links with history are severed and the basis of allocation is entirely in terms of average enrolments. A typical set of figures (N1=1) for which the historical (initial) proportion of resources allocated to group 1 was 0.4 and which sets current average enrolment in the group at 0.46 of the total leads to an allocation proportion of 0.43 i.e. the modified history policy with N1=1 has redistributed resources by about half the difference between the historical ratio and the present value based on average enrolments.

Equation 4 (CST1)

Provides a variety of cost change options for the modeller. The cost/student in a given group can be varied with
(a) step input (C11=1)
(b) exponentially (C12=1)
(c) according to any input table function (C13=1)

Equation 5 (OUT1)

This equation writes in the condition that each year group resources are depleted to zero.

Equation 6 - 15

Analogous equations for groups 2 and 3.

Equation 16 (ENR1)

The enrolment (entry) rate is expressed as the minimum of the application rate and the maximum number of students that can be coped with. The model is initialized in equilibrium where cost/student has an accepted "normal" value for the particular group. In this formulation of the model these values are arbitrarily assigned. For example C1=500 means that $500 per year is regarded as the "normal" cost of educating a student. If the average amount of money expended per student is less than this it means that the enrolment is higher than "normal" relative to available resources. As the average cost/student decreases it means that available resources are being spread increasingly thinly which will be associated with a reduction in the quality of education and a rise in staff work loads. (For this purpose all resources are aggregated). A critical value of cost/WSU exists (CCR1) which provides an absolute quality cut off. If this value is reached there will be a bar to further enrolments unless the resource position is improved. Under normal applicant pressure (except in courses with rigidly enforced quotas) students are enrolled and the average cost/WSU ratio allowed to drift downwards. This would be indicated by a rise in student/staff ratios. When the critical value is reached an enrolment limit is imposed unless further resources become available In a situation of declining enrolments all applicants are accepted and in some cases the cost/student ratio will be more favourable than the "normal" value. These conditions will make the group relatively favoured and render it vulnerable to resource transfer. The choice of parameters defining CCR1 determine how much elasticity in the valuation of student/resource ratios is allowed for.

Equation 17 (APP1)

The application rate is defined in terms of the pool of qualified applicants aspiring to university places. The intention is to subject the system to various input conditions including enrolment shocks. Consequently a variety of options are provided for in this exogenous influence.

(a) steady intake and/or shock
(b) exponential growth
(c) periodic (sinusoidal) variation
(d) generalised table input

An arbitrary equilibrium value of 5000 applicants per group is chosen to initialise the model. This figure may be taken to include those already in the system from previous year.

Equations 18 and 19 (Critical ratios groups)

These equations define the critical value of cost/WSU for group 1. The choice of 0.75 for CR1 allows the cost/student to drift down to 3/4 of its "normal" or adequate value before criticality occurs. A value of CR1 close to 1 represents a tight quota policy which keeps a close check on the resource/student balance. The model mechanism enables switch changes to be made to the parameter values that can be used t model a tightening or a relaxing of quotas during the course of a run. It is felt however that a major aim is to find policies and mechanisms that control much variables endogenously. Legislative actions such as quota impositions are essentially restrictive in the constraints that they place upon the system. They are also a source of intertia if quotas are not filled and slack exists elsewhere. Hence an aim is to provide the structural freedom for the system to move to unfavourable balances should appropriate conditions occur but to try to control its operation so that this does not in fact occur.

Equations 20-27 Parallel equations for groups 2 and 3

Equation 28-30 (Average Enrolment Rates)

The averaged (smoothed) enrolment rate calculated with an averaging time of 3 years. This is the observable stable indicator of enrolment size. Changes in the average enrolment rate signify changes in the group composition and substantial changes signal the need for reallocation of resources. The moving exponential average is updated yearly in terms of each new intake.

Equation 31 (Planned enrolment rate)

This equation expresses the planned enrolment rate for group 1 in terms of the rate based on past demand (DPENR1) together with a term representing planned developments in the group (PD1). Further discussion on these variables follows later (equation 73).

Equations 32-40

These equations describe the planning mechanism for group 1 with respect to projected enrolments. Essentially they project enrolments for year T+1 in terms of known data up to year T-1 and projected growth rates. For example it is assumed that the resources for 1987 students become available by the end of 1986 and that submissions supporting this resource claim are made in 1985. The projection mechanism (which involves projecting enrolment rates including changes in them) is overidden in the case of quotas in which numbers are pre-set by formula. The delay (DLPIPE) functions in the formulation reflect that resources eventually made available are a delayed manifestation of system conditions predicted at the time of submission.

Equation 41-60 (Parallel equations for groups 2 and 3)

Equation 61 (DISC1)

This equation defines the group 1 "discrepancy" or relative disadvantage/advantage of group 1. Initially with the system in equilibrium DISC1=1. If now the average enrolment in group 1 increases while the quantity of resources remains fixed then the resources are spread more thinly and DISC1<1 represents a condition of disadvantage. Similarly DISC1>1 represents a condition of relative advantage with respect to "normal" conditions.

Equation 62 and 63 (parallel equations for groups 2 and 3)

Equation 64 (RESL)

RESL defines the resources left after allocation of resources to groups from the available central (controlling) fund.

Equation 65 (SUMD)

This variable is the sum of the discrepancies of the groups. The variables CRAT1 etc are particular values of the discrepancy variables as discussed under equation 85.

Equation 66 (SPENR)

This variable is the cost weighted sum of planned enrolment rates across all groups.

Equation 67 (SPENR)

Sum of the reciprocals of the respective terms in equation 66.

Equation 68 (SAVENR)

Weighted sum of average enrolments x cost/WSU taken across all groups.

Equation 69 (SRDISC)

Sum of the reciprocals of the discrepancies in the respective groups.

Equation 70 (ADJ1)

This equation needs to be considered together with equation 73.

This equation contains 3 options for the application of an adjustment allocation that follows the basic allocation to groups. As indicated elsewhere adjustments can be regarded as essential when it becomes necessary for share cuts in funding or when there is supplementation to distribute.

There is however opportunity to make adjustments part of the normal procedure by withholding a percentage of total resources at the basic allocation stage. In the present formulation the latter option has not been included and the adjustment mechanism applies when the basic allocation over-allocates the available resources, or when resources remain after the basic allocation. A question remans as to how adjustments are to be apportioned. Possibilities include

(a) pro-rata adjustments - this really does not involve any additional policy but an original formula applied to a different amount. It is still in one sense equivalent to a single allocation.
(b) adjustments based on enrolments but not pro-rata
(c) adjustments based on discrepancies in which an attempt is made to equalise advantage or disadvantage within groups.

The three adjustment policies modelled are activated by the switches P1A, P1B,P1C.

(a) Enrolment based adjustment (P1A=1)

If the central controlling resources have been exceeded in the basic allocation (RESL<0) then reduce each group's resources in proportion to their cost weighted contribution to planned-enrolments. This is effectively a pro-rata reduction.

If controlling resources remain after the basic allocation (or supplements arrive) then distribute in proportion to cost/weighted average enrolments.

(b) Discrepancy based adjustment (P1B=1)

If central controlling resources have been exceeded in the basic allocation (RESL<0) then reduce each group's resources in proportion to the group discrepancy (CRAJ) so that those groups with a lower discrepancy (more disadvantage) lose relatively less. If RESL>0 then distribute additional funds in proportion to (1/CRAT) so that disadvantaged groups receive relatively more.

(c) Enrolment based adjustment - reverse feedback (P1C=1)

If RESL<0 then reduce in proportion to the inverse of cost weighted planned enrolments on the grounds that those with the greatest planned commitment should take the lowest cut rather than the highest cut as occurs in pro-rata adjustments.

Combinations of policies are possible e.g. combining a discrepancy and an enrolment formula together as in

P1A=P1B=1/2, P1/C=0

Other possibilities would be to give all additional resources to those group(s) with particularly bad discrepancies or to protect such groups from shared cut sharing. This policy effectively replaces a proportional policy with one based on criticality - groups deemed critical receiving treatment more substantial than a shared proportional basis would allow.

Equations 71 and 72

Adjustment mechanisms for groups 2 and 3.

Equation 73 (PD1) - planned development

This equation should be considered together with equation 31 of which it forms part. Writing out equation 31 to include equation 73 as a component gives

```
PENR1.K=(AVENR1.K-DPENR1.K) *PEWT11+(GOAL1.K-DPENR1.K)*PEWT12
+ (DPENR1.K)*PEWT13.
```

This equation is central to the model as it defines the method of basic allocation of resources to group 1. The operation of various policies is achieved via the switching constants (planned enrolment weights) PEWT11 etc. To define a policy all weights other than those cited are set to zero.

(a)	PEWT13=1:	planned enrolment is entirely on the basis of student demand as described in equations 32 to 40
(b)	PEWT13=PEWT12=1	planned enrolment is entirely on the basis of an external numbers policy defined by GOAL and has no direct link with past enrolment.
(c)	PEWT13=PEWT11=1	planned enrolment is on the basis of the most recently available "stable" information which is the constantly updated value of average enrolment. The latest changes in average enrolments would be used in allocating group budgets in any given year.
(d)	PEWT11=PEWT12=1/2	planned enrolment is weighted 50% to an external goal and 50% by average enrolments for the purpose of resource allocation. System conditions are used to modify differences between goals and enrolments An infinite variety of combinations are possible but all are essentially composites of the fundamental alternatives of (i) planned enrolments as projections based on past growth and change patterns (ii) planned enrolments as average values of enrolment rates. (iii) planned enrolments as defined by external growth targets.

Equations 74 and 75 (Parallel equations for groups 2 and 3)

Equation 76(Goal 1)

A pre-set ramp function that prescribes an external growth target for group 1:- linear growth of 2% per year for 12 years from T=3.

Equations 77-78 (parallel equations for groups 2 and 3).

Equations 79-84
These equations define the central controlling resource

available as the source of group funds. The resources (CR) arrive in consequence of a funding rate (FUND) and the outrate (SPEND) clears the resources each calendar year. The formulation of FUND indicates that the central resources are increased through the amount of external funds made available (EXT) and are reduced if funds remain unspent (RESID). The variable EXT includes a variety of funding options that incorporate both endogenous and exogenous influences.

(a) base allocation + step input of funds
(b) exponential growth of funds
(c) ramp growth of funds
(d) free table input to define funding rate
(e) demand generated funding rate representing feedback
    from planned developments

NOTE: The step function option enables the inclusion of effects such as 10% cut in projected funds or a sudden boost in funds.

Together with application rates and cost components the exogenous funding components represent the exogenous inputs to the system.

Equation 83-84 (RESID)

RESID provides an "average" estimate of total funds unspent.

The additional variable RED is the particular value of RESID appropriate to the end of each year

Equation 85 (CRAT1)

This important indicator variable defines the value of the group 1 discrepancy at the instant that the university resources are received, and consequently measures relative group advantage (disadvantage) at year T for conditions in year T. The nature of the simulation process means that the discrepancy variables (such as DISC1) are updated in such a way that sometimes they include a partial distribution of future resources. In particular the value of DISC1 printed out at the end of year T will be in terms of resources for year T+1 but applied to enrolment conditions in year T. The variable CRAT1 gives a time measure of the group discrepancy for year T.

Equations 86-87

Parallel equations for groups 2 and 3

Equations 88-92

These are non-essential internal variables. They have been set up to check the functioning of the model equations by providing data on calculations at intermediate time periods.

Equation 93 (EFFIC1)

This variable defines an arbitrary efficiency criterion, and provides a measure of the extent to which the external resources have been allocated. A value of 1 indicates that allocation has matched income. Values (<>1) indicate an (under/over) allocation of resources.

Equation 94 (EFFIC2)

This second efficiency measure is a softer index in that it is based upon average enrolments and as such is an estimate rather than a measure EFFIC2 estimates the extend to which target objectives are met with respect to average enrolments. A value of 1 indicates that resources have been exactly matched to funding requirements based on average enrolments. This need not always coincide with EFFIC1=1. Since that can be achieved providing all resources are disbursed and hence if for example substantial resources are assigned to a group with small numbers. Values of EFFIC2 estimate how closely policies manage to meet target numbers based on the "average cost" per WSU according to group.

Equation 95 An optional measure indicating on a cumulative

basis the differences between expenditure and funding.

Equation 102 (ALLRT1)

This allocation ratio for group 1 measures the magnitude of the adjustment allocation to group 1 in relation to the basic allocation during the same year. The variable is non-essential to model interpretation.

Equations 103-104

Equations parallel to 102 for groups 2 and 3.

APPENDIX C - MODEL EQUATIONS

```
DOC
* GRI RESOURCE MODEL (ENROL SHOCK)
NOTE
NOTE GROUP1 RESOURCES
NOTE
L GR1.K=GR1.J+DT*(RALG1.JK-OUT1.JK) - - - - - - - - EQ 1
N GR1=C1*INTAK1
R RALG1.KL=P1*PULSE((PENR1.K*CST1.K)/DT,.750,1)+PULSE(ADJ1.K/DT,.875,1)   EQ 2
X1         +H1*PULSE(HIST1.K*CR.K/DT,.750,1)
X2         +O1*PULSE(STEP(OTF11,OFST11)-STEP(OTF12,OFST12),.750,1)
A HIST1.K=(GR1I+N1*AVENR1.K*CST1.K)/(SUMG+N1*SAVENR.K)---EQ3
N GR1I=GR1
N SUMG=GR1+GR2+GR3
A CST1.K=C11*(C1+STEP(CHGT1,CTS1)) - - - - - - - - EQ4
X1        +C12*C1*SAMPLE(EXP(TIME.K/DT*LOGN(1+S1*DT)),1,1)
X2        +SAMPLE(TABHL(TABC1,TIME.K,0,15,15),1,0)
T TABC1=0,0
C H1=1,P1=0,N1=0,O1=1
C OTF11=0,OTF12=0
C OFST11=3,OFST12=3
C C1=500
C C11=1
C C12=0
C CHGT1=0
C CTS1=3
C S1=.04
R OUT1.KL=PULSE(GR1.K/DT,.750,1) - - - - - - EQ 5
NOTE
NOTE GROUP2 RESOURCES
NOTE
L GR2.K=GR2.J+DT*(RALG2.JK-OUT2.JK) - - - - EQ 6
N GR2=C2*INTAK2
R RALG2.KL=P2*PULSE((PENR2.K*CST2.K)/DT,.750,1)+PULSE(ADJ2.K/DT,.875,1)   EQ 7
X1         +H2*PULSE(HIST2.K*CR.K/DT,.750,1)
X2         +O2*PULSE(STEP(OTF21,OFST21)-STEP(OTF22,OFST22),.750,1)
A HIST2.K=(GR2I+N2*AVENR2.K*CST2.K)/(SUMG+N2*SAVENR.K)--EQ 8
N GR2I=GR2
A CST2.K=C21*(C2+STEP(CHGT2,CTS2)) - - - - - EQ 9
X1        +C22*C2*SAMPLE(EXP(TIME.K/DT*LOGN(1+S1*DT)),1,1)
X2        +SAMPLE(TABHL(TABC2,TIME.K,0,15,15),1,0)
T TABC2=0,0
C H2=1,P2=0,N2=0,O2=1
C OTF21=0,OTF22=0
C OFST21=3,OFST22=3
C C2=500
C C21=1
C C22=0
C CHGT2=0
C CTS2=3
R OUT2.KL=PULSE(GR2.K/DT,.750,1) - - - - - - - - - EQ 10
NOTE
```

BEST COPY AVAILABLE

```
NOTE GROUP3 RESOURCES
NOTE
L GR3.K=GR3.J+DT*(RALG3.JK-OUT3.JK)— — — — — — — EQ 11
N GR3=C3*INTAK3                                      EQ 12
R RALG3.KL=P3*PULSE((PENR3.K*CST3.K)/DT,.750,1)+PULSE(ADJ3.K/DT,.975,1)
X1        +R3*PULSE(HIST3.K*CR.K/DT,.750,1)
X2        +O3*PULSE(STEP(OTP31,OPST31)-STEP(OTP32,OPST32),.750,1)
A HIST3.K=(GR3I+R3*AVENR3.K*CST3.K)/(SUMO+R3*SAVENR.K)— — EQ 13
N GR3I=GR3
A CST3.K=C31*(C3+STEP(CHGT3,CTS3))— — — — — — — — EQ 14
X1      +C32*C3*SAMPLE(EXP(TIME.K/DT*LOGN(1+S1*DT)),1,1)
X2      +SAMPLE(TABHL(TABC3,TIME.K,0,15,15),1,0)
T TABC3=0,0
C R3=1,P3=0,O3=0,J3=1
C OTP31=0,OTP32=0
C OPST31=3,OPST32=3
C C3=500
C C31=1
C C32=0
C CHGT3=0
C CTS3=3
R OUT3.KL=PULSE(GR3.K/DT,.750,1)— — — — — — — — — — EQ 15
NOTE
NOTE ENROLMENT RATES GROUPS 1,2&3
NOTE
R ENR1.KL=MIN(APP1.K,SAMPLE(GR1.K,1,GR1I)/CCR1.K)— — — — EQ 16
A APP1.K=V11*(INTAK1+STEP(VHGT1,VST1))+V12*INTAK1*SAMPLE(EXP(TIME.K/DT     EQ 17
X1      *LOGN(1+S3*DT)),1,1)+V13*AMP1*INTAK1
X2      *SAMPLE(SIN(6.283*TIME.K/PERD),1,0)
X3      +SAMPLE(TABHL(TABA1,TIME.K,0,15,15),1,0)
T TABA1=0,0
A CCR1.K=CR1.K*CST1.K — — — — — — — — — — — EQ 18
A CR1.K=CLIP(R11,R12,SWT1,TIME.K)— — — — — — — — — EQ 19
C V11=1
C V12=0
C V13=0
C S3=.02
C AMP1=.2
C PERD=10
C INTAK1=5000
C VHGT1=1000
C VST1=3
C R11=.75
C R12=.75
C SWT1=4
R ENR2.KL=MIN(APP2.K,SAMPLE(GR2.K,1,GR2I)/CCR2.K)— — — — EQ 20
A APP2.K=V21*(INTAK2+STEP(VHGT2,VST2))+V22*INTAK2*SAMPLE(EXP(TIME.K/DT     EQ 21
X1      *LOGN(1+S3*DT)),1,1)+V23*AMP2*INTAK2
X2      *SAMPLE(SIN(6.283*TIME.K/PERD),1,0)
X3      +SAMPLE(TABHL(TABA2,TIME.K,0,15,15),1,0)
T TABA2=0,0
A CCR2.K=CR2.K*CST2.K — — — — — — — — EQ 22
A CR2.K=CLIP(R21,R22,SWT2,TIME.K)— — — — — — — — EQ 23
C V21=1
C V22=0
C V23=0
C INTAK2=5000
C VHGT2=0
C VST2=3
C R21=.75
C R22=.75
C AMP2=.2
C SWT2=4
R ENR3.KL=MIN(APP3.K,SAMPLE(GR3.K,1,GR3I)/CCR3.K)— — — EQ 23
A APP3.K=V31*(INTAK3+STEP(VHGT3,VST3))+V32*INTAK3*SAMPLE(EXP(TIME.K/DT
X1      *LOGN(1+.04*DT)),1,1)+V33*AMP3*INTAK3                           EQ 24
X2      *SAMPLE(SIN(6.283*TIME.K/PERD),1,0)
```

BEST COPY AVAILABLE

```
T TABA3=0,0
A CCR3.K=CR3.K*CST3.K
A CR3.K=CLIP(R31,R32,SWT3,TIME.K)_ — — — — — — — — — — EQ 26
C V31=1                                                  — EQ 27
C V32=0
C V33=0
C INTAK3=5000
C VROT3=-1000
C VST3=3
C R31=.75
C R32=.75
C AMP3=.2
C SWT3=4
NOTE
NOTE AVERAGE ENROLMENT RATES GROUPS 1,2&3
NOTE
L AVENR1.K=AVENR1.J+(DT/EAT)*PULSE((ENR1.JK-AVENR1.J)/DT,0,1)_ _ _EQ 28
N AVENR1=GR1/C1
C EAT=3
L AVENR2.K=AVENR2.J+(DT/EAT)*PULSE((ENR2.JK-AVENR2.J)/DT,0,1)_ _ _EQ 29
N AVENR2=GR2/C2
L AVENR3.K=AVENR3.J+(DT/EAT)*PULSE((ENR3.JK-AVENR3.J)/DT,0,1)_ _ _EQ 30
N AVENR3=GR3/C3
NOTE
NOTE PLANNED ENROLMENT RATE  GROUP  1
NOTE
A PENR1.K=PD1.K+PERT13*DPENR1.K — — — — — — — EQ 31
C PERT13=1
L DENR11.K=DENR11.J+DT*(DEIN11.JK-DOUT11.JK) _ — — — — - EQ 32
N DENR11=GR1/C1
TP PREV11=0,0,40000,0,0,0,0,0
R DEIN11.KL=DLPIPE(PREV11,AV1.JK,DEL1) _ — — — — — — — EQ 33
R AV1.KL=PULSE(AVENR1.K/DT,.525,1)
R DOUT11.KL=PULSE(DENR11.K/DT,.025,1)_ — — — — — — EQ 34
C DEL1=1                              — — — — — — — — —EQ 35
L DENR12.K=DENR12.J+DT*(DEIN12.JK-DOUT12.JK)— — — — — —EQ 36
N DENR12=GR1/C1
TP PREV12=0,0,40000,0,0,0,0,0,0,0,40000,0,0,0,0,0
R DEIN12.KL=DLPIPE(PREV12,AV1.JK,DEL2) — — — — — — — — EQ 37
R DOUT12.KL=PULSE(DENR12.K/DT,.025,1) — — — — — — - EQ 38
C DEL2=2
A DPENR1.K=DENR11.K*(1+ENRAT1.K)*(1+ENRAT1.K)— — — — — - EQ 39
A ENRAT1.K=((DENR11.K-DENR12.K)/DENR12.K)*DRT1 — — — — — — EQ 40
C DRT1=1
NOTE
NOTE PLANNED ENROLMENT RATE GROUP2
NOTE
A PENR2.K=PD2.K+PERT23*DPENR2.K — — — — — — — — — — — - EQ 41
C PERT23=1
L DENR21.K=DENR21.J+DT*(DEIN21.JK-DOUT21.JK) — — — — — — - EQ 42
N DENR21=GR2/C2
TP PREV21=0,0,40000,0,0,0,0,0
R DEIN21.KL=DLPIPE(PREV21,AV2.JK,DEL1)— — — — — — — — —EQ 43
R AV2.KL=PULSE(AVENR2.K/DT,.025,1)_ — — — — — — — — - EQ 44
R DOUT21.KL=PULSE(DENR21.K/DT,.025,1)_ — — — — — — — EQ 45
L DENR22.K=DENR22.J+DT*(DEIN22.JK-DOUT22.JK) — — — — — — - EQ 46
N DENR22=GR2/C2
TP PREV22=0,0,40000,0,0,0,0,0,0,0,40000,0,0,0,0,0
R DEIN22.KL=DLPIPE(PREV22,AV2.JK,DEL2) — — — — — — — EQ 47
R DOUT22.KL=PULSE(DENR22.K/DT,.025,1) — — — — — — —   EQ 48
A DPENR2.K=DENR21.K*(1+ENRAT2.K)*(1+ENRAT2.K)— — — — — - EQ 49
A ENRAT2.K=((DENR21.K-DENR22.K)/DENR22.K)*DRT2 — — — — — EQ 50
C DRT2=1
```

BEST COPY AVAILABLE

```
NOTE PLANNED ENROLMENT GROUP3
NOTE
A PENR3.K=PD3.K+PENT33*DPENR3.K — — — — — — —  EQ 51
C PENT33=1
L DENR31.K=DENR31.J+DT*(DEIN31.JK-DOUT31.JK) — — — — — — EQ52
N DENR31=GR3/C3
TP PREV31=0,0,40000,0,0,0,0,0
R DEIN31.KL=DLPIPE(PREV31,AV3.JK,DEL1) — — — — — —  EQ53
R AV3.KL=PULSE(AVENR3.K/DT,.025,1) — — — — — — — — — EQ54
R DOUT31.KL=PULSE(DENR31.K/DT,.025,1)— — — — — — — — — EQ55
L DENR32.K=DENR32.J+DT*(DEIN32.JK-DOUT32.JK)— — — — — — — EQ56
N DENR32=GR3/C3
TP PREV32=0,0,40000,0,0,0,0,0,0,0,40000,0,0,0.0,0
R DEIN32.KL=DLPIPE(PREV32,AV3.JK,DEL2)— — — — — — —  EQ57
R DOUT32.KL=PULSE(DENR32.K/DT,.025,1) — — — — — — — —  EQ58
A DPENR3.K=DENR31.K*(1+ENRAT3.K)*(1+ENRAT3.K)— — — — — — — EQ59
A ENRAT3.K=((DENR31.K-DENR32.K)/DENR32.K)*DNT3 — — — — — —  EQ60
C DNT3=1
NOTE
NOTE DISCREPANCIES GROUPS 1,2&3
NOTE
A DISC1.K=GR1.K/(AVENR1.K*CST1.K)— — — — — — — — — EQ61
A DISC2.K=GR2.K/(AVENR2.K*CST2.K)— — — — — — — — — EQ62
A DISC3.K=GR3.K/(AVENR3.K*CST3.K)— — — — — — — — — — EQ63
NOTE
NOTE RESOURCES REMAINING FOR ALLOCATION
NOTE
A RESL.K=GR.K-(GR1.K+GR2.K+GR3.K)— — — — — — — —  EQ64
NOTE
NOTE SUM OF DISCREPANCIES
NOTE
A SUMD.K=CRAT1.K+CRAT2.K+CRAT3.K — — — — — — — — — EQ65
NOTE
NOTE SUM OF PLANNED ENROLMENT RATES
NOTE
A SPENR.K=PENR1.K*CST1.K+PENR2.K*CST2.K+PENR3.K*CST3.K— — — —  EQ66
NOTE
NOTE SUM OF RECIP PLANNED ENR RATES  (COST WEIGHTED)
NOTE
A SRPENR.K=1/(PENR1.K*CST1.K)+1/(PENR2.K*CST2.K)+1/(PENR3.K*CST3.K)-- EQ67
NOTE
NOTE SUM OF AVERAGE ENROLMENT RATES
NOTE
A SAVENR.K=AVENR1.K*CST1.K+AVENR2.K*CST2.K+AVENR3.K*CST3.K — — — EQ 68
NOTE
NOTE SUM OF RECIPROCAL DISCREPANCIES
NOTE
A SRDISC.K=(1/CRAT1.K)+(1/CRAT2.K)+(1/CRAT3.K) — — — — — — — EQ 69
NOTE
```

BEST COPY AVAILABLE

```
NOTE ADJUSTED FUNDING RATES FOR GROUPS 1,2&3
NOTE
A ADJ1.K=P1A*(CLIP(AVENR1.K*CST1.K/SAVENR.K,0,RESL.K,0)*RESL.K_ _ _ _EQ 70
X1            +CLIP(PENR1.K*CST1.K/SPENR.K,0,0,RESL.K)*RESL.K)
X2       +P1B*(CLIP(1/CRAT1.K/SRDISC.K,0,RESL.K,0)*RESL.K
X3            +CLIP(CRAT1.K/SUMD.K,0,0,RESL.K)*RESL.K)
X4       +P1C*(CLIP(AVENR1.K*CST1.K/SAVENR.K,0,RESL.K,0)*RESL.K
X5            +CLIP(1/(PENR1.K*CST1.K)/SRPENR.K,0,0,RESL.K)*RESL.K)
A ADJ2.K=P2A*(CLIP(AVENR2.K*CST2.K/SAVENR.K,0,RESL.K,0)*RESL.K_ _ _ _EQ 71
X1            +CLIP(PENR2.K*CST2.K/SPENR.K,0,0,RESL.K)*RESL.K)
X2       +P2B*(CLIP(1/CRAT2.K/SRDISC.K,0,RESL.K,0)*RESL.K
X3            +CLIP(CRAT2.K/SUMD.K,0,0,RESL.K)*RESL.K)
X4       +P2C*(CLIP(AVENR2.K*CST2.K/SAVENR.K,0,RESL.K,0)*RESL.K
X5            +CLIP(1/(PENR2.K*CST2.K)/SRPENR.K,0,0,RESL.K)*RESL.K)
A ADJ3.K=P3A*(CLIP(AVENR3.K*CST3.K/SAVENR.K,0,RESL.K,0)*RESL.K _ _ _ EQ 72
X1            +CLIP(PENR3.K*CST3.K/SPENR.K,0,0,RESL.K)*RESL.K)
X2       +P3B*(CLIP(1/CRAT3.K/SRDISC.K,0,RESL.K,0)*RESL.K
X3            +CLIP(CRAT3.K/SUMD.K,0,0,RESL.K)*RESL.K)
X4       +P3C*(CLIP(AVENR3.K*CST3.K/SAVENR.K,0,RESL.K,0)*RESL.K
X5            +CLIP(1/(PENR3.K*CST3.K)/SRPENR.K,0,0,RESL.K)*RESL.K)
C P1A=1,P2A=1,P3A=1
C P1B=0,P2B=0,P3B=0
C P1C=0,P2C=0,P3C=0
NOTE
NOTE PLANNED DEVELOPMENTS GROUPS 1,2&3
NOTE
A PD1.K=(AVENR1.K-DPENR1.K)*PENT11+(GOAL1.K-DPENR1.K)*PENT12 _ _ _ _ EQ 73
A PD2.K=(AVENR2.K-DPENR2.K)*PENT21+(GOAL2.K-DPENR2.K)*PENT22 _ _ _ _ EQ 74
A PD3.K=(AVENR3.K-DPENR3.K)*PENT31+(GOAL3.K-DPENR3.K)*PENT32 _ _ _ _ EQ 75
C PENT11=0,PENT21=0,PENT31=0
C PENT12=0,PENT22=0,PENT32=0
A GOAL1.K=SAMPLE(INTAK1+RAMP(GSLP1,GST1),1,INTAK1) _ _ _ _ _ EQ 76
A GOAL2.K=SAMPLE(INTAK2+RAMP(GSLP2,GST2),1,INTAK2) _ _ _ _ _ _ EQ 77
A GOAL3.K=SAMPLE(INTAK3+RAMP(GSLP3,GST3),1,INTAK3) _ _ _ _ _ _ EQ 78
C GSLP1=100,GSLP2=100,GSLP3=100
C GST1=3,GST2=3,GST3=3
NOTE
NOTE AVAILABLE CONTROLLING RESOURCE
NOTE
L CR.K=CR.J+DT*(FUND.JK-SPEND.JK) _ _ _ _ _ _ _ _ _ _ EQ 79
N CR=BASE
R FUND.KL=PULSE((EXT.K-FWT*CLIP(RESID.K,0,RESID.K,0))/DT,.025,1)_ _ _EQ 80
R SPEND.KL=PULSE(CR.K/DT,.025,1) _ _ _ _ _ _ _ _ _ _ EQ 81
A EXT.K=E1*BASE+STEP(EHGT,EST)+E2*BASE*EXP(TIME.K/DT*LOGN(1+S2*DT))_ _ EQ 82
X1       +E3*SAMPLE(BASE+RAMP(EXSLP,EXST),1,BASE)
X2       +SAMPLE(TABHL(TABEXT,TIME.K,0,15,15),1,0)
X3       +E4*(DPENR1.K*CST1.K+DPENR2.K*CST2.K+DPENR3.K*CST3.K)
C FWT=1
T TABEXT=0,0
C E1=0
C E2=0
C E3=0
C E4=1
C EHGT=0
C EST=3
C S2=.02
N EXSLP=GSLP1*C1+GSLP2*C2+GSLP3*C3
C EXST=2
N BASE=GR1+GR2+GR3
A RESID.K=CR.K-(AVENR1.K*CST1.K+AVENR2.K*CST2.K+AVENR3.K*CST3.K)_ _ _EQ 83
L RED.K=RED.J+DT*(PULSE(RESID.J/DT,0,1)-PULSE(RED.J/DT,0,1))_ _ _ _ EQ 84
N RED=0
```

```
NOTE
NOTE OTHER SYSTEM INDICATORS
NOTE
L CRAT1.K=CRAT1.J+DT*(PULSE(DISC1.J/DT,.625,1) - - - - - - EQ 85
X                    -PULSE(CRAT1.J/DT,.625,1))
N CRAT1=DISC1
L CRAT2.K=CRAT2.J+DT*(PULSE(DISC2.J/DT,.625,1) - - - - - - EQ 86
X                    -PULSE(CRAT2.J/DT,.625,1))
N CRAT2=DISC2
L CRAT3.K=CRAT3.J+DT*(PULSE(DISC3.J/DT,.625,1) - - - - - - EQ 87
X                    -PULSE(CRAT3.J/DT,.625,1))
N CRAT3=DISC3
L RESLI.K=RESLI.J+DT*(PULSE(RESL.J/DT,.875,1)-PULSE(RESLI.J/DT,.875,1))-EQ88
N RESLI=RESL
L DISC1I.K=DISC1I.J+DT*(PULSE(DISC1.J/DT,.875,1) - - - - - - EQ 89
X                      -PULSE(DISC1I.J/DT,.875,1))
N DISC1I=DISC1
L DISC2I.K=DISC2I.J+DT*(PULSE(DISC2.J/DT,.875,1) - - - - - - EQ 90
X                      -PULSE(DISC2I.J/DT,.875,1))
N DISC2I=DISC2
L DISC3I.K=DISC3I.J+DT*(PULSE(DISC3.J/DT,.875,1) - - - - - - EQ 91
X                      -PULSE(DISC3I.J/DT,.875,1))
N DISC3I=DISC3
A EFFICI.K=1-RESLI.K/CR.K - - - - - - - - - - EQ 92
A EFFIC1.K=1-RESL.K/CR.K - - - - - - - - - - EQ 93
A EFFIC2.K=1-RESID.K/CR.K - - - - - - - - - - EQ 94
L COMRED.K=COMRED.J+DT*PULSE(RESID.J/DT,.625,1) - - - - - - - EQ 95
N COMRED=RED
L ADJ1I.K=ADJ1I.J+DT*(PULSE(ADJ1.J/DT,.875,1)-PULSE(ADJ1I.J/DT,.875,1)) EQ96
N ADJ1I=0
L ADJ2I.K=ADJ2I.J+DT*(PULSE(ADJ2.J/DT,.875,1)-PULSE(ADJ2I.J/DT,.875,1)) EQ97
N ADJ2I=0
L ADJ3I.K=ADJ3I.J+DT*(PULSE(ADJ3.J/DT,.875,1)-PULSE(ADJ3I.J/DT,.875,1)) EQ98
N ADJ3I=0
L BALL1I.K=BALL1I.J+DT*(PULSE((PENR1.J*CST1.J)/DT,.75,1) - - - - EQ 99
X                        -PULSE(BALL1I.J/DT,.75,1))
N BALL1I=PENR1*CST1
L BALL2I.K=BALL2I.J+DT*(PULSE((PENR2.J*CST2.J)/DT,.75,1) - - - - EQ 100
X                        -PULSE(BALL2I.J/DT,.75,1))
N BALL2I=PENR2*CST2
L BALL3I.K=BALL3I.J+DT*(PULSE((PENR3.J*CST3.J)/DT,.75,1) - - - - EQ 101
X                        -PULSE(BALL3I.J/DT,.75,1))
N BALL3I=PENR3*CST3
A ALLRT1.K=ADJ1I.K/BALL1I.K - - - - - - - - - EQ 102
A ALLRT2.K=ADJ2I.K/BALL2I.K - - - - - - - - - EQ 103
A ALLRT3.K=ADJ3I.K/BALL3I.K - - - - - - - - - EQ 104
NOTE CONTROL STATEMENTS AND OUTPUT REQUESTS
NOTE
C DT=.125
C LENGTH=15
C PRTPER=1
C PLTPER=1
PRINT 1)GR1,GR2,GR3,ENR1,ENR2,ENR3
X1       /2)AVENR1,AVENR2,AVENR3,PENR1,PENR2,PENR3
X2       /3)DISC1I,DISC2I,DISC3I,DISC1,DISC2,DISC3
X3       /4)CRAT1,CRAT2,CRAT3,ADJ1I,ADJ2I,ADJ3I
X4       /5)RESLI,EFFICI,RESL,EFFIC1,RED,EFFIC2
X5       /6)ALLRT1,ALLRT2,ALLRT3,FUND,COMRED,CR
PLOT GR1=A,GR2=B,GR3=C
PLOT AVENR1=D,AVENR2=E,AVENR3=F,CST1=G,CST2=H,CST3=I
PLOT PENR1=R,PENR2=S,PENR3=T,ENR1=M,ENR2=N,ENR3=P
PLOT CRAT1=A,CRAT2=B,CRAT3=C
```

```
NOTE
NOTE VARIABLE DEFINITIONS
NOTE
D ALLRT1=(1) ALLOC RATIO GP1
D ALLRT2=(1)
D ADJ11=($/YR) ADJUST FOR GIVEN YR TO GP1
D ADJ21=($/YR)
D ADJ31=($/YR)
D ALLRT3=(1)
D AMP1=(1) AMPL MULTIPLIER FOR PERIODIC INPUT GP1
D AMP2=(1) AMPL MULTIPLIER FOR PERIODIC INPUT GP2
D AMP3=(1) AMPL MULTIPLIER FOR PERIODIC INPUT GP3
D BALL11=($/YR) BASIC ALLOC FOR GIVEN YR TO GP1
D BALL21=($/YR)
D BALL31=($/YR)
D CUMRED=($/YR) CUMULATIVE VALUE OF RED
D CRAT1=(1) DISCREP  RATIO GP1
D CRAT2=(1) DISCREP  RATIO GP2
D CRAT3=(1) DISCREP  RATIO GP3
D DPENR1=(WSU/YR) DEMAND BASED PLANNED ENROLMENT GP1
D DPENR2=(WSU/YR) DEMAND BASED PLANNED ENROLMENT GP2
D DPENR3=(WSU/YR) DEMAND BASED PLANNED ENROLMENT GP3
D DENR11=(WSU/YR) AVER ENROL IN GP1(DELAY=1YR)
D DENR12=(WSU/YR) AVER ENROL IN GP2(DELAY=2YR)
D DEIN11=(WSU/YR/YR) INRATE FOR DENR11
D DEIN12=(WSU/YR/YR) INRATE FOR DENR12
D DOUT11=(WSU/YR/YR) OUTRATE FOR DENR11
D DOUT12=(WSU/YR/YR) OUTRATE FOR DENR12
D DENR21=(WSU/YR)
D DENR22=(WSU/YR)
D DEIN21=(WSU/YR/YR)
D DEIN22=(WSU/YR/YR)
D DOUT21=(WSU/YR/YR)
D DOUT22=(WSU/YR/YR)
D DENR31=(WSU/YR)
D DENR32=(WSU/YR)
D DEIN31=(WSU/YR/YR)
D DEIN32=(WSU/YR/YR)
D DOUT31=(WSU/YR/YR)
D DOUT32=(WSU/YR/YR)
D AV1=(WSU/YR/YR) OUTRATE FOR AVENR1
D AV2=(WSU/YR/YR) OUTRATE FOR AVENR2
D AV3=(WSU/YR/YR) OUTRATE FOR AVENR3
D DEL1=(YR) PLANNING DELAY TIME
D DEL2=(YR)
D ENRAT1=(1) PLANNING RATIO GP1
D ENRAT2=(1)
D ENRAT3=(1)
D DWT1=(1) ENROL PLANNING WEIGHT GP1
D DWT2=(1)
D DWT3=(1)
D CCR1=($/WSU) CRIT VALUE OF COST FOR GP1
D CCR2=($/WSU) CRIT VALUE OF COST FOR GP2
D CCR3=($/WSU) CRIT VALUE OF COST FOR GP3
D CR1=(1) CRIT COST PROPORT FOR GP1
D CR2=(1) CRIT COST PROPORT FOR GP2
D CR3=(1) CRIT COST PROPORT FOR GP3
D R11=(1) CRIT COST PROPORT FOR GP1-INITIAL
D R12=(1) CRIT COST PROPORT FOR GP1-SWITCH
D R21=(1) CRIT COST PROPORT FOR GP2-INITIAL
D R22=(1) CRIT COST PROPORT FOR GP2-SWITCH
D R31=(1) CRIT COST PROPORT FOR GP3-INITIAL
D R32=(1) CRIT COST PROPORT FOR GP3-SWITCH
D SWT1=(YR) SWITCH TIME FOR CR1
D SWT2=(YR) SWITCH TIME FOR CR2
D SWT3=(YR) SWITCH TIME FOR CR3
```

BEST COPY AVAILABLE

```
D APP1=(WSU/YR) APPLIC RATE FOR GP1
D APP2=(WSU/YR) APPLIC RATE FOR GP2
D APP3=(WSU/YR) APPLIC RATE FOR GP3
D ADJ1=($/YR) ADJUSTMENT TO GP1 ALLOC
D ADJ2=($/YR) ADJUSTMENT TO GP2 ALLOC
D ADJ3=($/YR) ADJUSTMENT TO GP3 ALLOC
D AVENR1=(WSU/YR) AVERAGE ENROLMENT RATE IN GP1
D AVENR2=(WSU/YR) AVERAGE ENROLMENT RATE IN GP2
D AVENR3=(WSU/YR) AVERAGE ENROLMENT RATE IN GP3
D BASE=($/YR) BASE ALLOC OF CONTROLLING RESOURCE(FUNDING) TO SYSTEM
D C1=($/WSU) INIT COST/WSU IN GP1
D C2=($/WSU) INIT COST/WSU IN GP2
D C3=($/WSU) INIT COST/WSU IN GP3
D C11=(1) SWITCH FOR CST1
D C12=(1) SWITCH FOR CST1
D C21=(1) SWITCH FOR CST2
D C22=(1) SWITCH FOR CST2
D C31=(1) SWITCH FOR CST3
D C32=(1) SWITCH FOR CST3
D CHGT1=($/WSU) STEP HEIGHT IN COST CHANGE/WSU IN GP1
D CHGT2=($/WSU) STEP HEIGHT IN COST CHANGE/WSU IN GP2
D CHGT3=($/WSU) STEP HEIGHT IN COST CHANGE/WSU IN GP3
D CR=($/YR) CONTROLLING RESOURCE AVAIL TO SYSTEM(EXTERNAL FUNDING)
D CST1=($/WSU) COST/WSU IN GP1
D CST2=($/WSU) COST/WSU IN GP2
D CST3=($/WSU) COST/WSU IN GP3
D CTS1=(YR) TIME STEP IN CST1
D CTS2=(YR) TIME STEP IN CST2
D CTS3=(YR) TIME STEP IN CST3
D DISC1=(1) PROPL ENROL DISCREPANCY IN GP1
D DISC2=(1) PROPL ENROL DISCREPANCY IN GP2
D DISC3=(1) PROPL ENROL DISCREPANCY IN GP3
D DISC1I=(1) PROPL ENROL DISCREP IN GP1 AFTER BASIC ALLOCATION
D DISC2I=(1) PROPL ENROL DISCREP IN GP2 AFTER BASIC ALLOCATION
D DISC3I=(1) PROPL ENROL DISCREP IN GP3 AFTER BASIC ALLOCATION
D DT=(YR) SOLUTION INTERVAL
D E1=(1) SWITCH CONST FOR EXT BASE&STEP
D E2=(1) SWITCH CONST FOR EXT EXPONENTIAL GROWTH
D E3=(1) SWITCH CONST FOR EXT RAMP
D E4=(1) SWITCH CONST FOR EXT PLANNED FUNDING
D EAT=(YR) ENROLMENT AVERAGING TIME
D EFFIC1=(1) PROPORTION OF TOTAL RESOURCES ALLOCATED
D EFFICI=(1) PROPN OF TOTAL RESOURCES COMMITTED IN BASIC ALLOCATION
D EFFIC2=(1) PROP OF STUDENT QUOTA MET
D EHGT=($/YR) STEP HEIGHT IN TOTAL FUNDING CHANGE
D ENR1=(WSU/YR) ENROL RATE IN GP1
D ENR2=(WSU/YR) ENROL RATE IN GP2
D ENR3=(WSU/YR) ENROL RATE IN GP3
D EST=(YR) TIME STEP OCCURS IN TOTAL FUNDING CHANGE
D EXT=($/YR) INPUT TO MODEL FROM EXTERNAL FUNDING AGENCY
D FUND=($/YR/YR) RATE OF CHANGE OF EXTERNAL FUNDING(CONTROLLING RESOURCE)
D GR1=($/YR) RESOURCES ALLOCATED TO GP1
D GR2=($/YR) RESOURCES ALLOCATED TO GP2
D GR3=($/YR) RESOURCES ALLOCATED TO GP3
D INTAK1=(WSU/YR) BASE INTAKE GP1
D INTAK2=(WSU/YR) BASE INTAKE GP2
D INTAK3=(WSU/YR) BASE INTAKE GP3
D LENGTH=(YR) LENGTH OF SIMULATION RUN
D OUT1=($/YR/YR) RATE OF RESOURCE DEPLETION IN GP1
D OUT2=($/YR/YR) RATE OF RESOURCE DEPLETION IN GP2
D OUT3=($/YR/YR) RATE OF RESOURCE DEPLETION IN GP3
```

BEST COPY AVAILABLE

```
D P1A=(1) POLICY SWITCH-GP1
D P1B=(1)
D P2A=(1) POLICY SWITCH-GP2
D P2B=(1)
D P3A=(1) POLICY SWITCH-GP3
D P3B=(1)
D PD1=(NSU/YR) ENROLMT FOR PLANNED DEVELOPMENT IN GP1
D PD2=(NSU/YR) ENROLMT FOR PLANNED DEVELOPMENT IN GP2
D PD3=(NSU/YR) ENROLMT FOR PLANNED DEVELOPMENT IN GP3
D PENR1=(NSU/YR) PLANNED ENROL RATE FOR GP1
D PENR2=(NSU/YR) PLANNED ENROL RATE FOR GP2
D PENR3=(NSU/YR) PLANNED ENROL RATE FOR GP3
D PERD=(YR) PERIOD OF SINE FUNCTION FOR ENROLMENT
D PREV11=(NSU/YR/YR) PREVIOUS VALUES OF AV1
D PREV12=(NSU/YR/YR)
D PREV21=(NSU/YR/YR) PREVIOUS VALUES OF AV2
D PREV22=(NSU/YR/YR)
D PREV31=(NSU/YR/YR) PREVIOUS VALUES OF AV3
D PREV32=(NSU/YR/YR)
D PLTPER=(YR) PLOTTING INTERVAL
D PRTPER=(YR) PRINTING INTERVAL
D RALC1=($/YR/YR) RATE OF RESOURCE ALLOCATION TO GP1
D RALC2=($/YR/YR) RATE OF RESOURCE ALLOCATION TO GP2
D RALC3=($/YR/YR) RATE OF RESOURCE ALLOCATION TO GP3
D RED=($/YR) REDUCTION IN CTRING RESOURCES DUE TO STUDENT SHORTFALL
D RESL=($/YR) CTRING RESOURCES LEFT AFTER GROUP ALLOCATIONS(+OR-)
D RESL1=($/YR) CTRING RESOURCES LEFT AFTER BASIC GP ALLOCATIONS(+OR-)
D RESIL=($/YR) RESIDUE OF CONTROLLING RESOURCES LEFT UNSPENT
D S1=(1/YR) RATE OF COST INCREASE
D S2=(1/YR) RATE OF GROWTH OF FUNDING
D S3=(1/YR) RATE OF GROWTH OF APPLICANTS FOR PLACES
D SPEND=($/YR/YR) RATE OF SPENDING OF CONTROLLING RESOURCE
D SPENR=($/YR) SUM OF PLANNED ENROLMENT RATE-COST WEIGHTED
D SUMD=(1) SUM OF DISCREPANCIES
D SAVENR=($/YR) SUM OF AVER ENROL RATES-COST WEIGHTED
D SRDISC=(1) SUM OF RECIPROCAL DISCREPANCIES
D TIME=(YR) SIMULATED TIME
D V11=(1) SWTCH CONST FOR APP1
D V12=(1) SWTCH CONST FOR APP1
D V13=(1) SWTCH CONST FOR APP1
D V21=(1) SWTCH CONST FOR APP2
D V22=(1) SWTCH CONST FOR APP2
D V23=(1) SWTCH CONST FOR APP2
D V31=(1) SWTCH CONST FOR APP3
D V32=(1) SWTCH CONST FOR APP3
D V33=(1) SWTCH CONST FOR APP3
D VHGT1=(NSU/YR) STEP HEIGHT IN ENROLMENT VARIATION TERM-GP1
D VHGT2=(NSU/YR) STEP HEIGHT IN ENROLMENT VARIATION TERM-GP2
D VHGT3=(NSU/YR) STEP HEIGHT IN ENROLMENT VARIATION TERM-GP3
D VST1=(YR) TIME STEP IN APP1 FUNCTION
D VST2=(YR) TIME STEP IN APP2 FUNCTION
D VST3=(YR) TIME STEP IN APP3 FUNCTION
D GOAL1=(NSU/YR) GOAL ENROL FOR GP1
D GOAL2=(NSU/YR) GOAL ENROL FOR GP2
D GOAL3=(NSU/YR) GOAL ENROL FOR GP3
D GSLP1=(NSU/YR) RAMP SLOPE FOR GP1 GOAL
D GSLP2=(NSU/YR) RAMP SLOPE FOR GP2 GOAL
D GSLP3=(NSU/YR) RAMP SLOPE FOR GP3 GOAL
D GST1=(YR) START TIME FOR GP1 RAMP
D GST2=(YR) START TIME FOR GP2 RAMP
D GST3=(YR) START TIME FOR GP3 RAMP
```

```
D PEWT11=(1) PLANNED ENROL WEIGHT FOR GP1
D PEWT12=(1) PLANNED ENROL WEIGHT FOR GP1
D PEWT13=(1) PLANNED ENROL WEIGHT FOR GP1
D PEWT21=(1) PLANNED ENROL WEIGHT FOR GP2
D PEWT22=(1) PLANNED ENROL WEIGHT FOR GP2
D PEWT23=(1) PLANNED ENROL WEIGHT FOR GP2
D PEWT31=(1) PLANNED ENROL WEIGHT FOR GP3
D PEWT32=(1) PLANNED ENROL WEIGHT FOR GP3
D PEWT33=(1) PLANNED ENROL WEIGHT FOR GP3
D EXSLP=($/YR) RAMP SLOPE FOR EXTERNAL FUNDING
D EXST=(YR) START TIME FOR FUNDING RAMP
D TABA1=(WSU/YR) TABLE APPLIC RATE FOR GP1
D TABA2=(WSU/YR) TABLE APPLIC RATE FOR GP2
D TABA3=(WSU/YR) TABLE APPLIC RATE FOR GP3
D TABC1=($/WSU) TABLE COST RATE FOR GP1
D TABC2=($/WSU) TABLE COST RATE FOR GP2
D TABC3=($/WSU) TABLE COST RATE FOR GP3
D TABEXT=($/YR) TABLE FUNDING RATE
D FWT=(1) FUNDING REDUCTION WEIGHT
D HIST1=(1) INIT PROP ALLOC TO GP1
D HIST2=(1)  "    "     "    " GP2
D HIST3=(1)  "    "     "    " GP3
D SUMG=($/YR) SUM OF GROUP RESOURCES (INIT)
D H1=(1) SWITCH FOR HISTORY POLICY GP1
D H2=(1)     "     "     "        "    GP2
D H3=(1)     "     "     "        "    GP3
D P1=(1)     "     "  PRAGMAT     "    GP1
D P2=(1)     "     "     "        "    GP2
D P3=(1)     "     "     "        "    GP3
D W1=(1)     "     " ADJ HIST     "    GP1
D W2=(1)     "     "     "        "    GP2
D W3=(1)     "     "     "        "    GP3
D O1=(1)     "     " OUTSIDE FUND EFFECT GP1
D O2=(1)     "     "     "        "    "   GP2
D O3=(1)     "     "     "        "    "   GP3
D OTF11=($/YR) STEP CHANGE IN OUTSIDE FUNDS GP1
D OTF12=($/YR)   "     "     "  "    "    "    "
D OTF21=($/YR)   "     "     "  "    "    "   GP2
D OTF22=($/YR)   "     "     "  "    "    "    "
D OTF31=($/YR)   "     "     "  "    "    "   GP3
D OTF32=($/YR)   "     "     "  "    "    "    "
D OFST11=(YR) STRT TIME FOR STEP FUNCT GP1
D OFST12=(YR)  "     "    "    "    "    "
D OFST21=(YR)  "     "    "    "    "   GP2
D OFST22=(YR)  "     "    "    "    "    "
D OFST31=(YR)  "     "    "    "    "   GP3
D OFST32=(YR)  "     "    "    "    "    "
D GR1I=($/YR) INIT VALUE OF GP1 RESOURCES
D GR2I=($/YR)  "     "    "  GP2    "
D GR3I=($/YR)  "     "    "  GP3    "
D P1C=(1) SWTCH FOR ADJ POLICY GP1
D P2C=(1)    "     "    "     "   GP2
D P3C=(1)    "     "    "     "   GP3
D SRPEWR=(YR/$) SUM OF RECIP PLANNED ENROL RATES(COST WEIGHTED)
T
```

BEST COPY AVAILABLE